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**Boyer et al.**

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(45) **Date of Patent: Dec. 29, 2015**

(54) **LUMINAIRES AND LUMINAIRE MOUNTING STRUCTURES**

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(22) Filed: **Nov. 5, 2013**

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(63) Continuation of application No. 13/828,446, filed on Mar. 14, 2013.

(51) **Int. Cl.**
***F21S 4/00*** (2006.01)
***F21S 8/00*** (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC . ***F21V 21/14*** (2013.01); ***F21K 9/00*** (2013.01); ***F21S 8/00*** (2013.01); ***F21S 8/02*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ..... F21Y 2105/00; F21Y 2105/001; F21V 31/00; F21V 31/005; F21V 31/03; F21V 31/04; F21V 21/00; F21V 21/02; F21V 21/03; F21V 21/06; F21V 21/14; F21V 21/116; F21V 29/83; F21V 29/507; F21V 17/101; F21V 17/107; F21V 17/12; F21V 17/18; F21V 19/00; F21V 19/0035; F21V 19/005; F21V 23/001; F21V 23/007; F21V 23/02; F21V 15/01; F21S 8/00; F21S 8/02; F21S 8/04; F21S 8/043; F21S 8/06; F21S 8/026; F21K 9/00
USPC ..... 362/267
See application file for complete search history.

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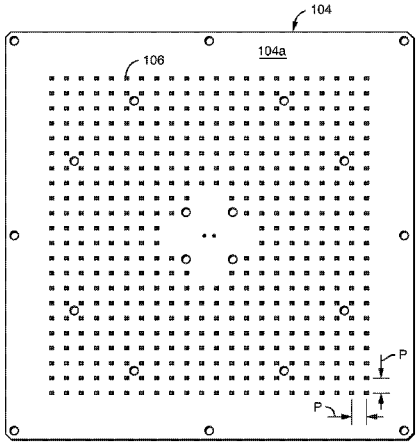
(57) **ABSTRACT**

A luminaire having a housing defining one or more unthreaded mounting holes therein, a connector having a head and a shaft, the connector shaft located at least partially in one of the one or more mounting holes, the connector shaft comprised of a pliable material, a circuit board mounted to the housing by the connector head, the circuit board populated with one or more LEDs, and a lens resting against and spaced form the circuit board by the connector head.

**17 Claims, 18 Drawing Sheets**



(51) **Int. Cl.**

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|---|---|
| ***F21V 21/14*** | (2006.01) |
| ***F21V 21/00*** | (2006.01) |
| ***F21V 5/04*** | (2006.01) |
| ***F21K 99/00*** | (2010.01) |
| ***F21V 31/00*** | (2006.01) |
| ***F21V 31/03*** | (2006.01) |
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| ***F21V 17/10*** | (2006.01) |
| ***F21V 17/12*** | (2006.01) |
| ***F21V 19/00*** | (2006.01) |
| ***F21V 21/02*** | (2006.01) |
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| ***F21V 21/06*** | (2006.01) |
| ***F21V 21/116*** | (2006.01) |
| ***F21S 8/02*** | (2006.01) |
| ***F21S 8/04*** | (2006.01) |
| ***F21S 8/06*** | (2006.01) |
| ***F21V 17/18*** | (2006.01) |
| ***F21V 23/00*** | (2015.01) |
| ***F21V 23/02*** | (2006.01) |
| ***F21V 29/507*** | (2015.01) |
| ***F21V 29/83*** | (2015.01) |
| *F21Y 105/00* | (2006.01) |

(52) **U.S. Cl.**

CPC .... ***F21S 8/04*** (2013.01); ***F21S 8/06*** (2013.01); ***F21V 5/04*** (2013.01); ***F21V 17/101*** (2013.01); ***F21V 17/107*** (2013.01); ***F21V 17/12*** (2013.01); ***F21V 17/18*** (2013.01); ***F21V 19/00*** (2013.01); ***F21V 19/005*** (2013.01); ***F21V 19/0035*** (2013.01); ***F21V 21/00*** (2013.01); ***F21V 21/02*** (2013.01); ***F21V 21/03*** (2013.01); ***F21V 21/06*** (2013.01); ***F21V 21/116*** (2013.01); ***F21V 23/001*** (2013.01); ***F21V 23/007*** (2013.01); ***F21V 23/02*** (2013.01); ***F21V 29/507*** (2015.01); ***F21V 29/83*** (2015.01); ***F21V 31/005*** (2013.01); ***F21V 31/03*** (2013.01); ***F21V 31/04*** (2013.01); *F21Y 2105/00* (2013.01)

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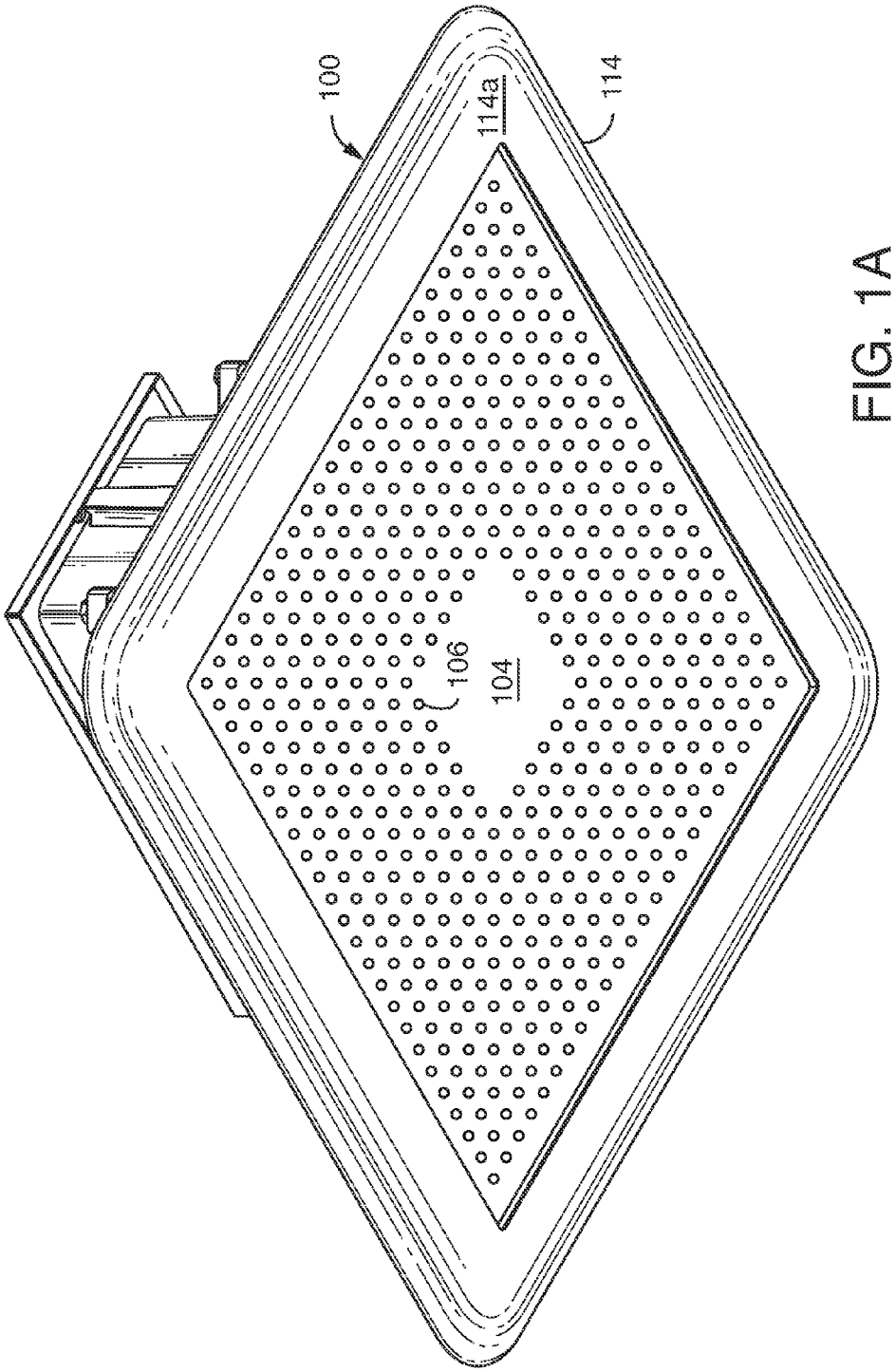


FIG. 1A

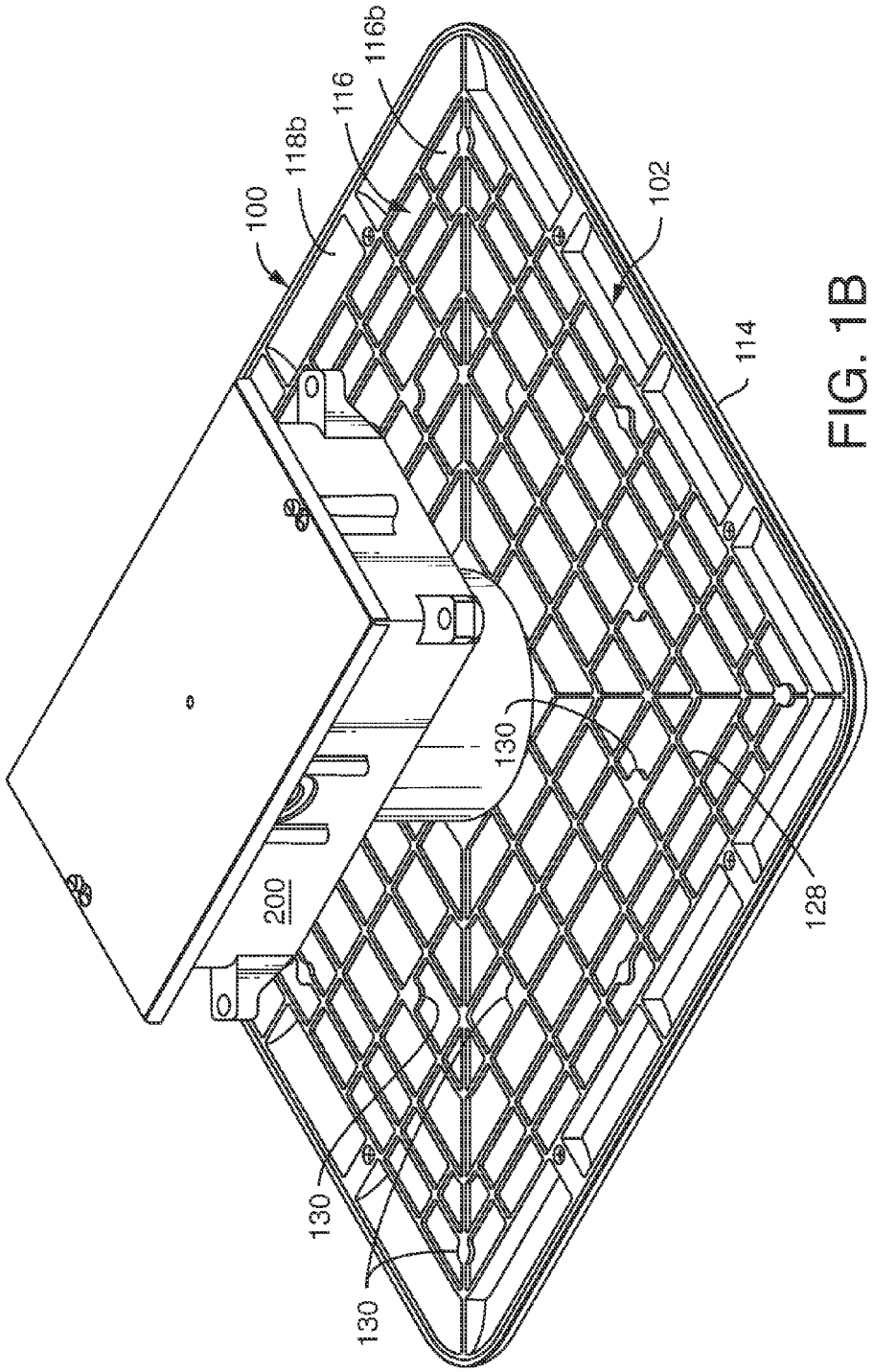


FIG. 1B

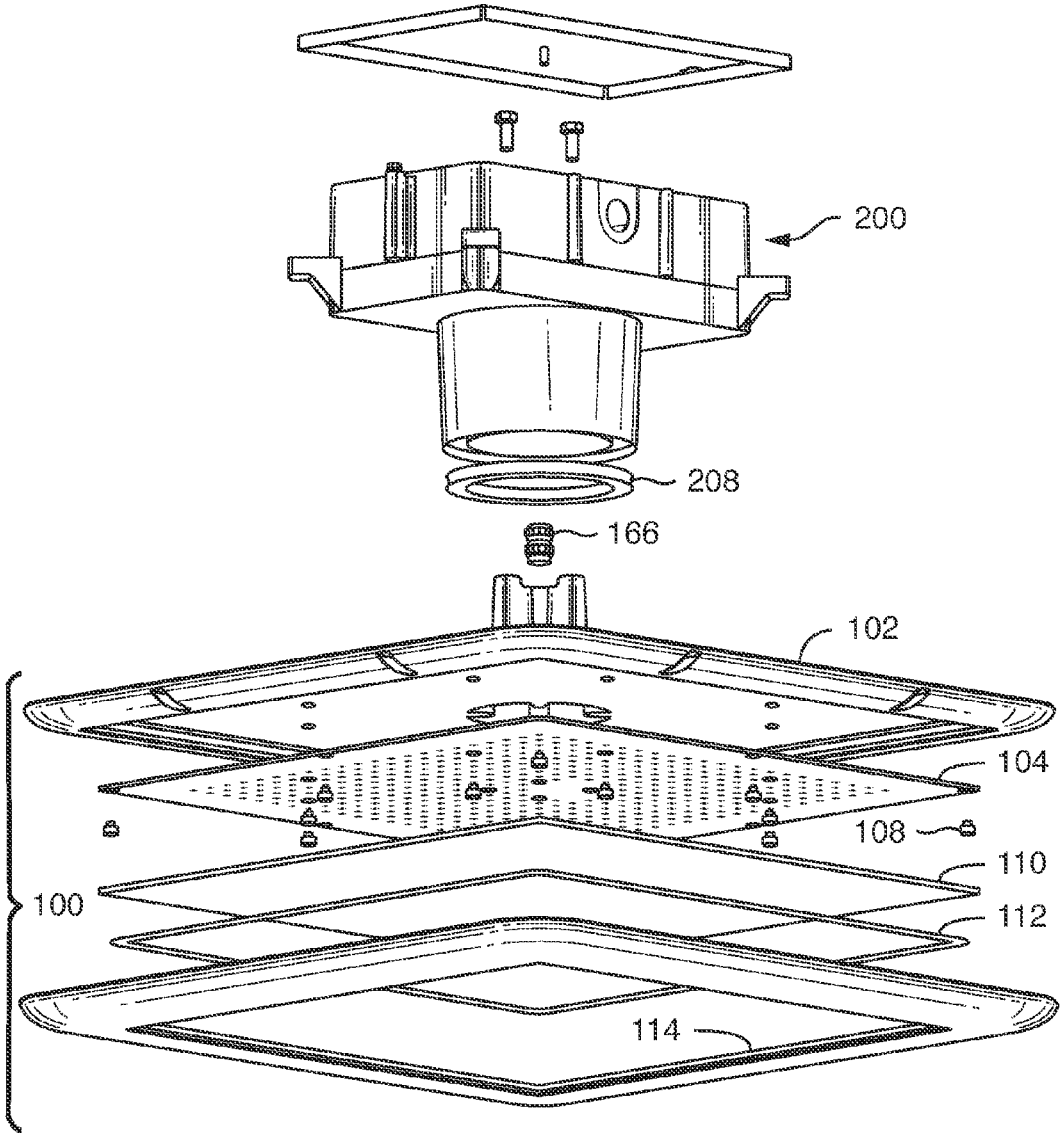


FIG. 1C

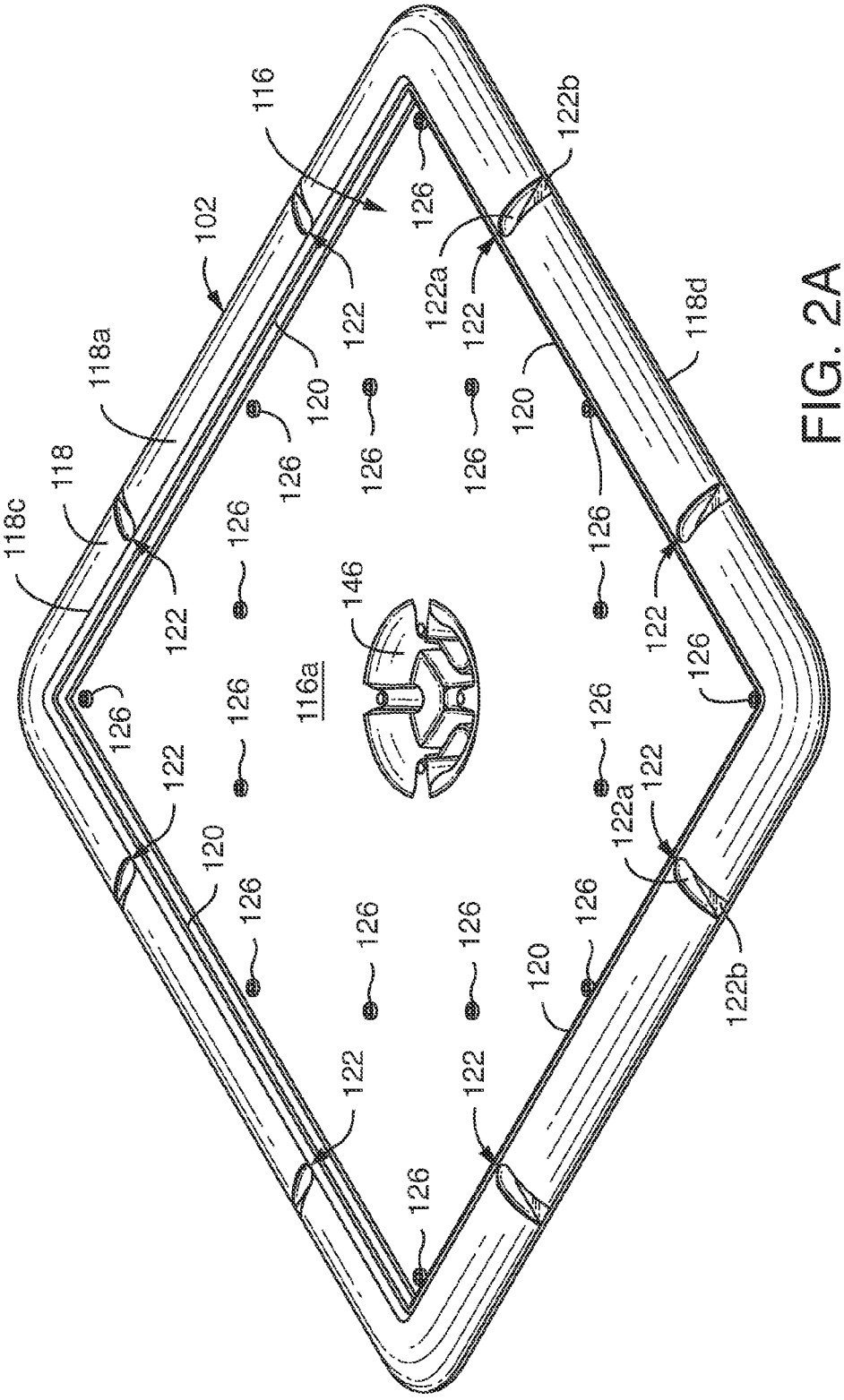
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FIG. 2A

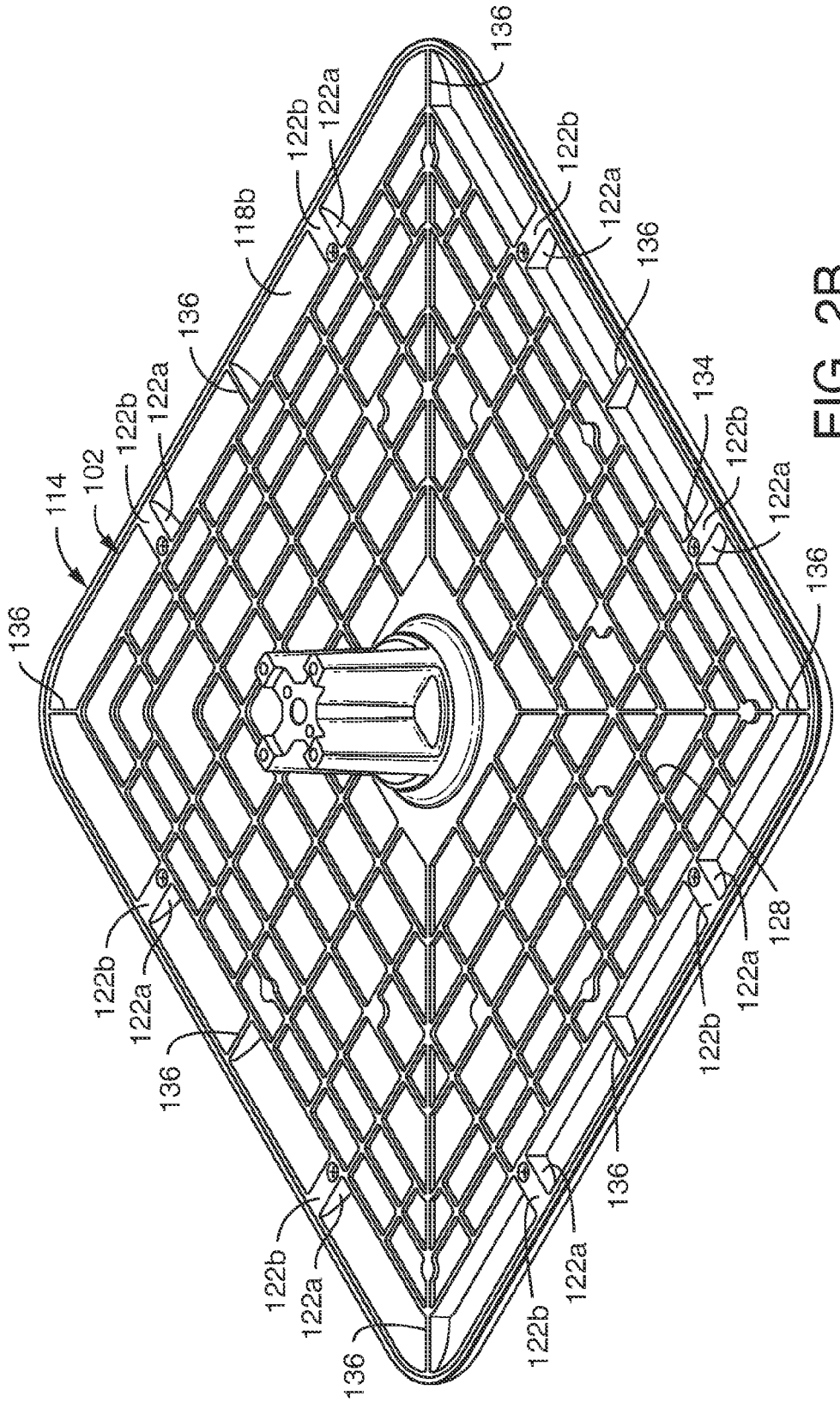


FIG. 2B

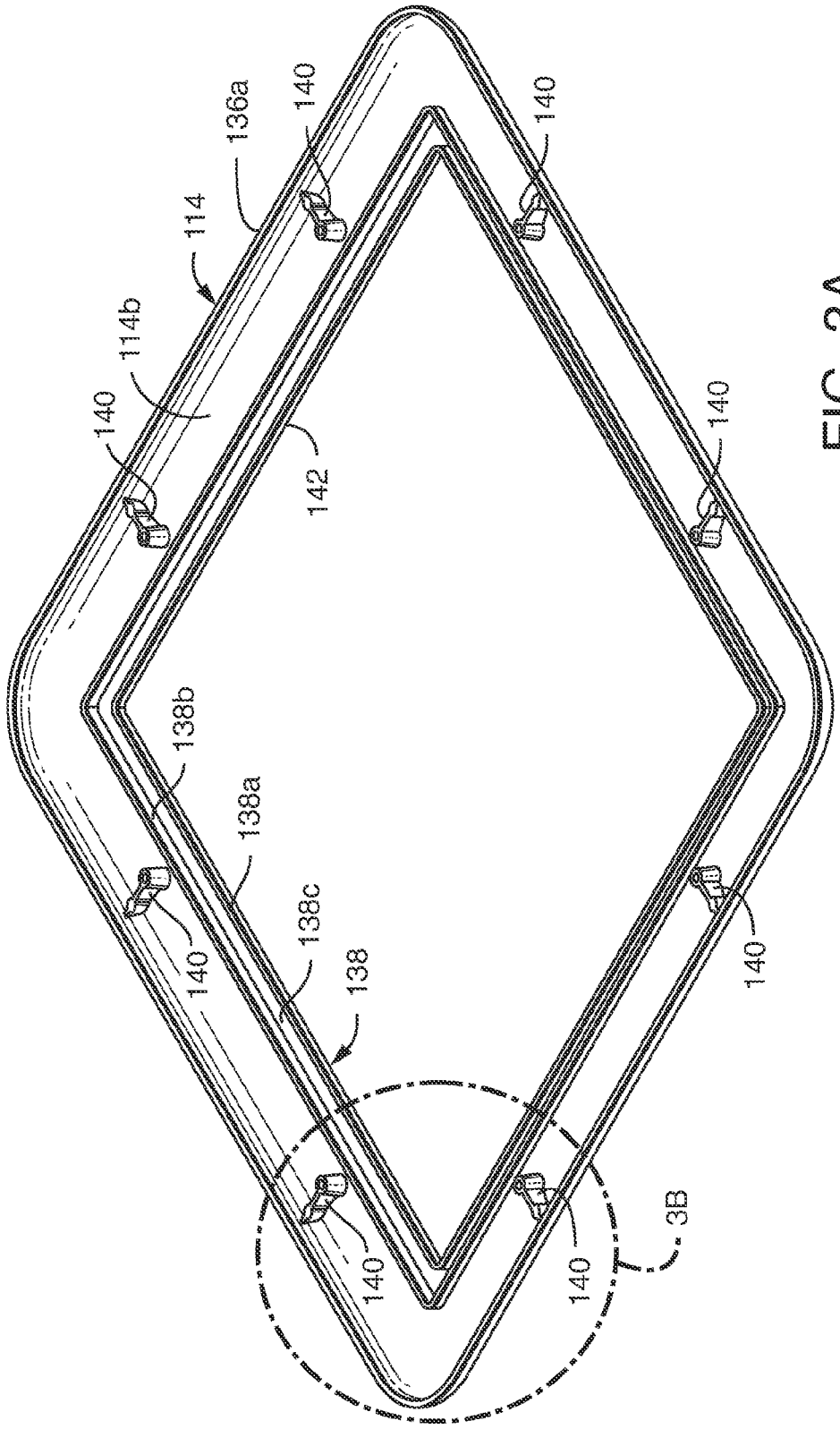
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FIG. 3A

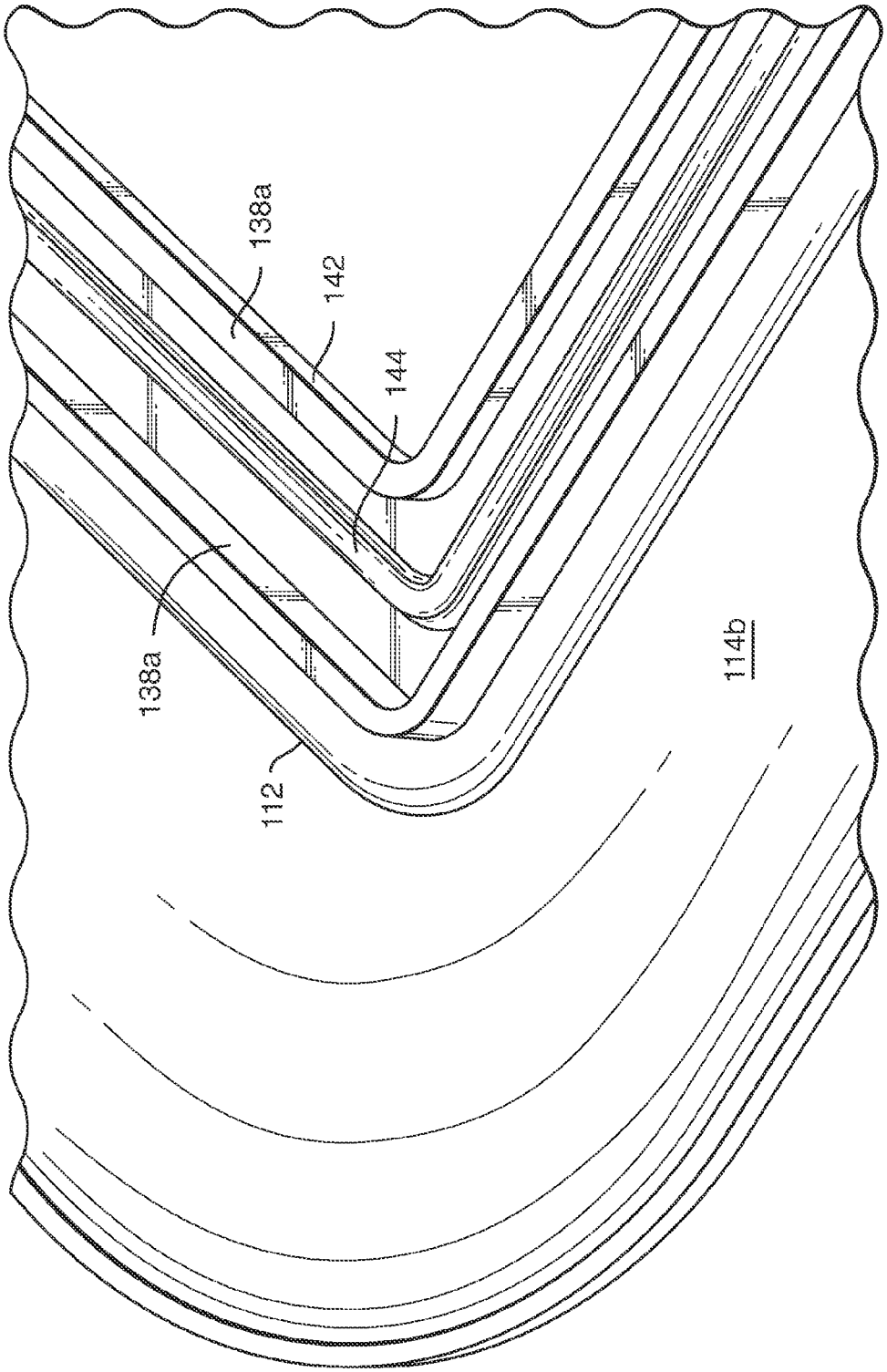



FIG. 3B

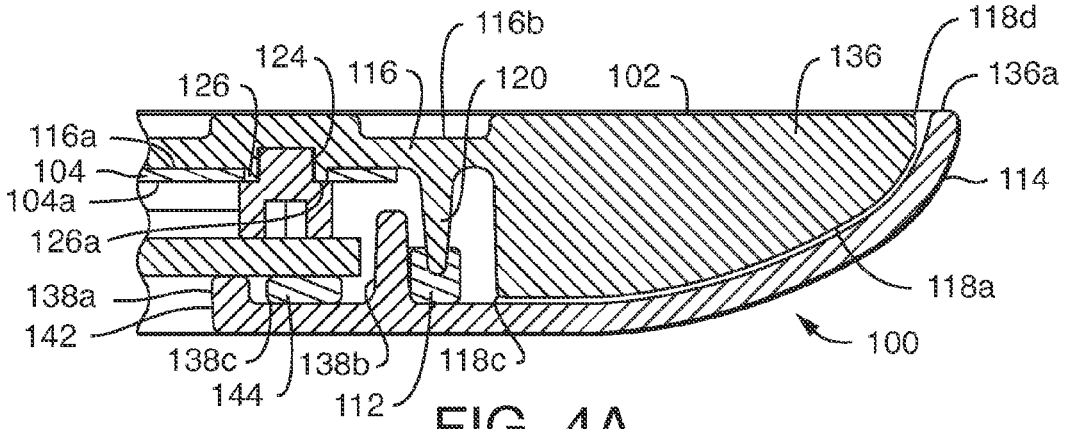



FIG. 4A

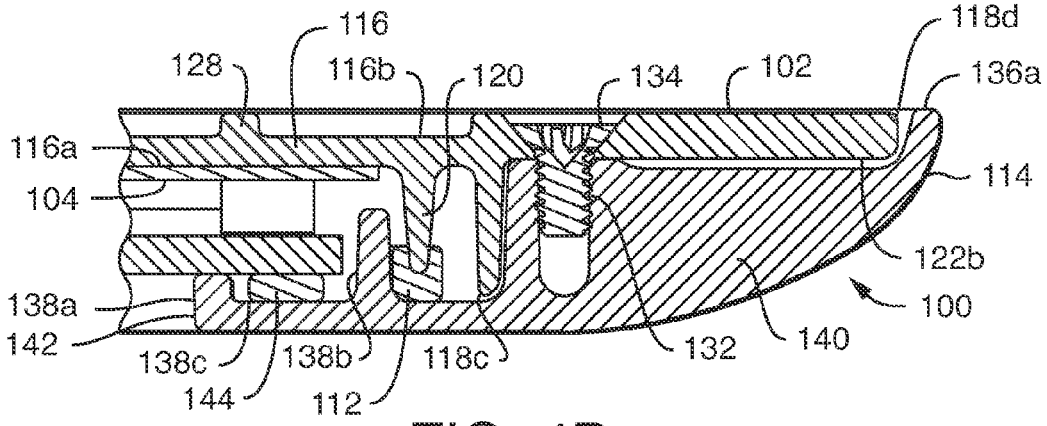



FIG. 4B

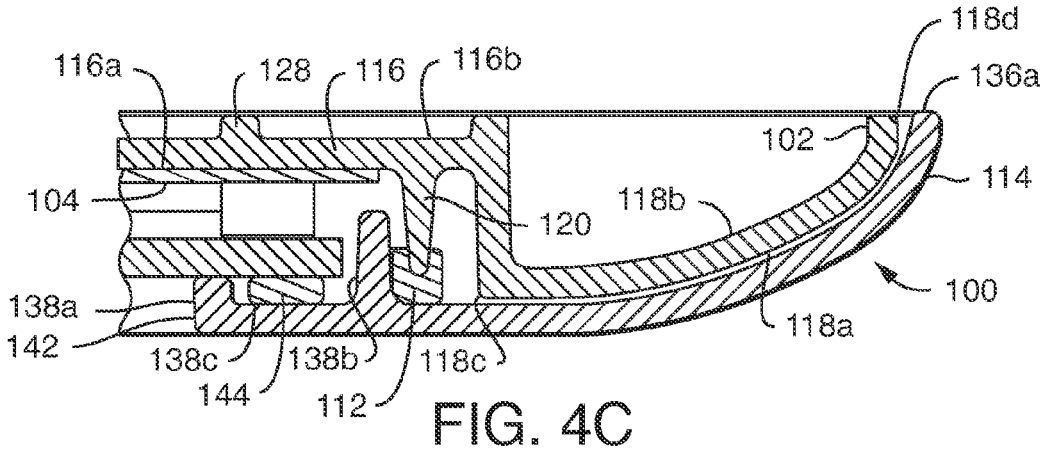
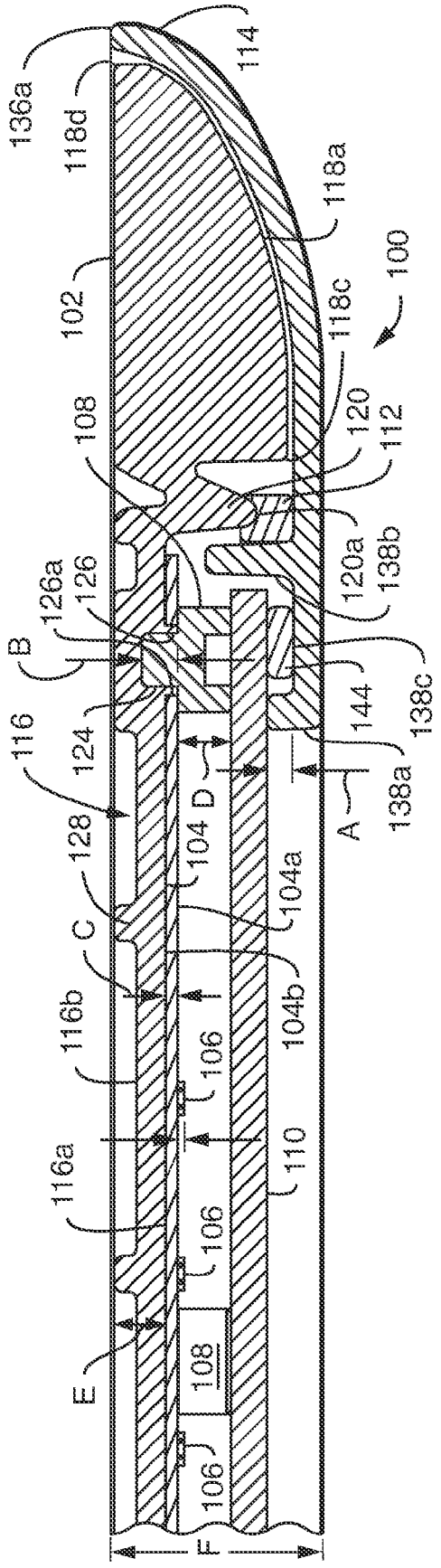



FIG. 4C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D
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104b
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E
106
F

FIG. 4D

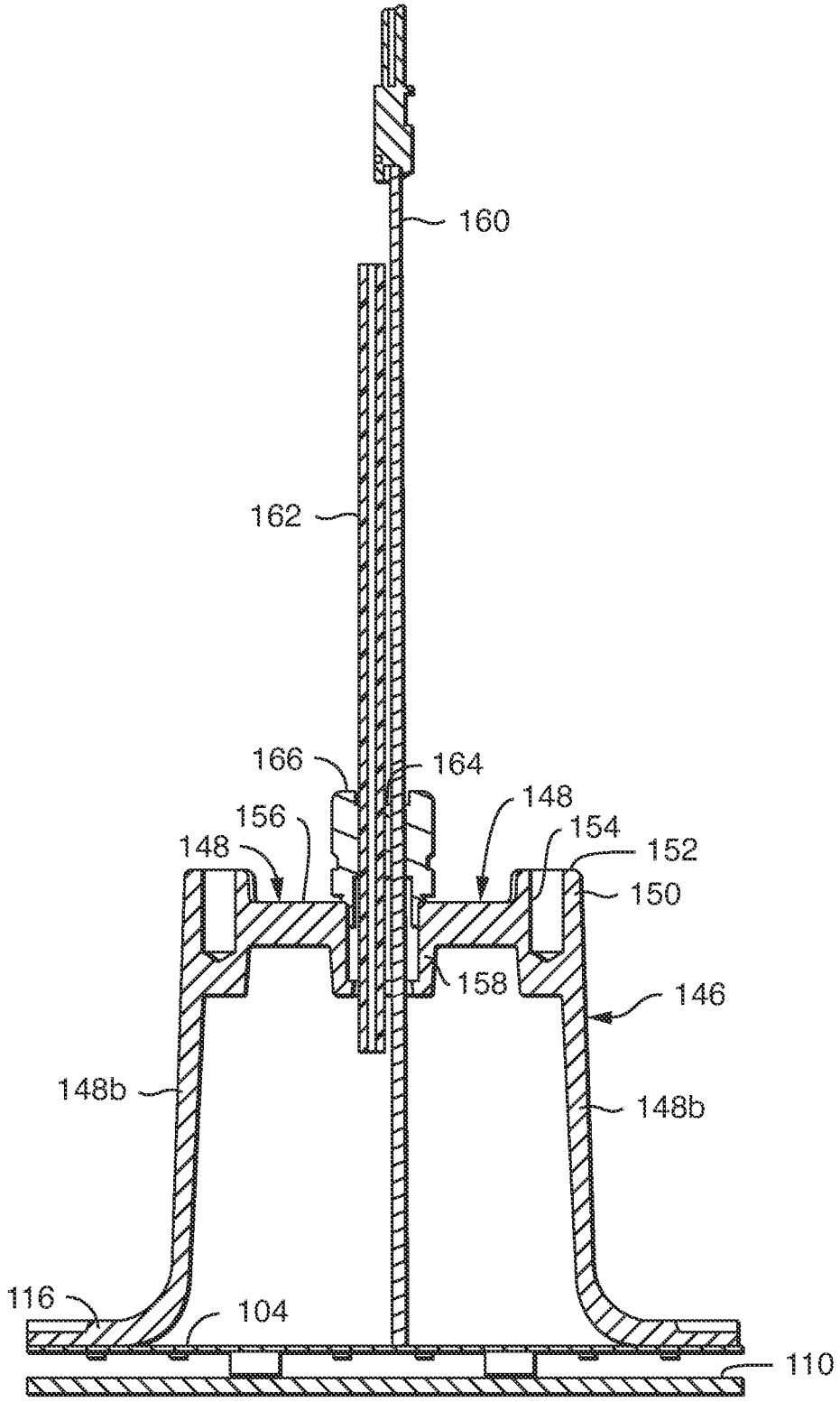
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FIG. 4E

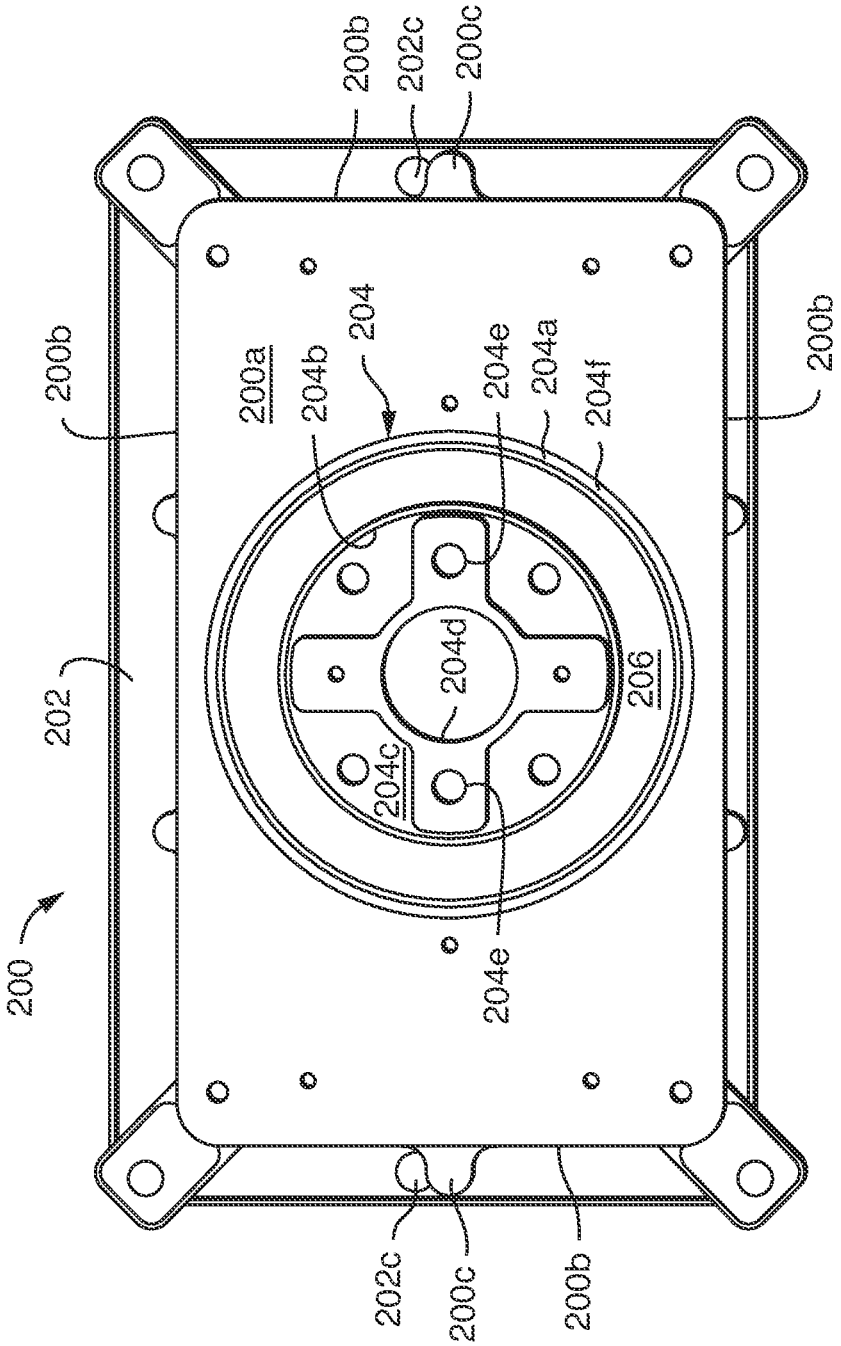
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FIG. 5A

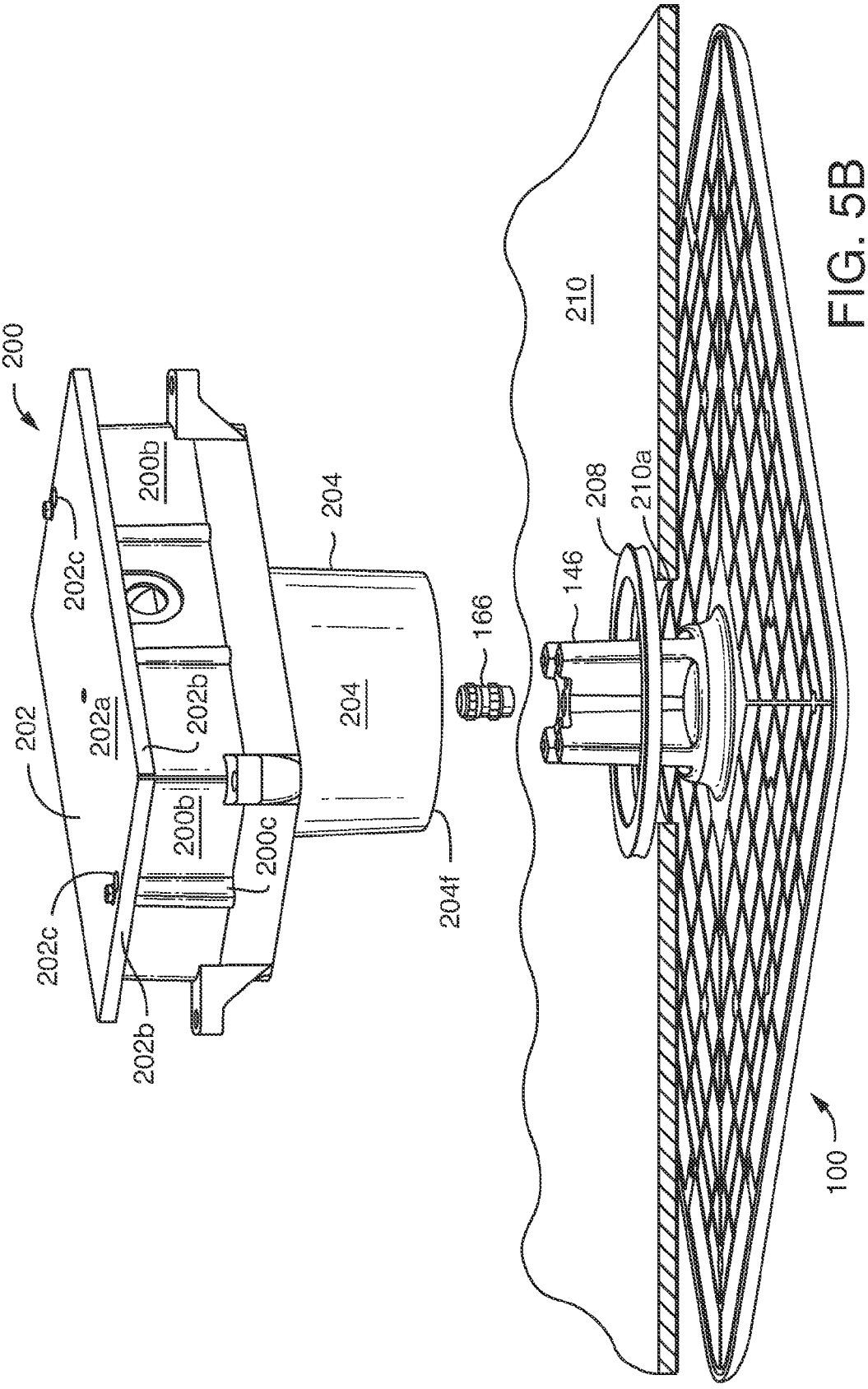
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FIG. 5B

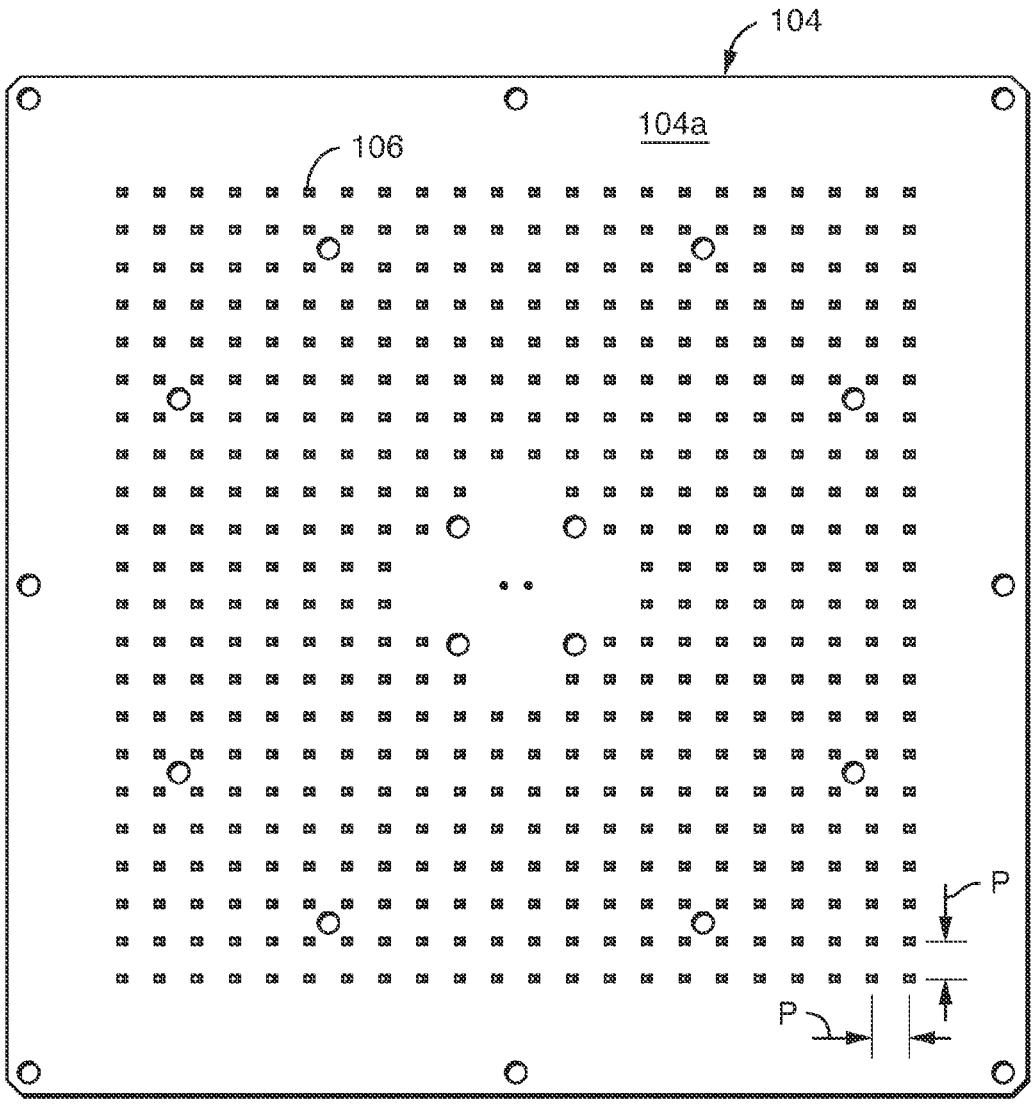


FIG. 6

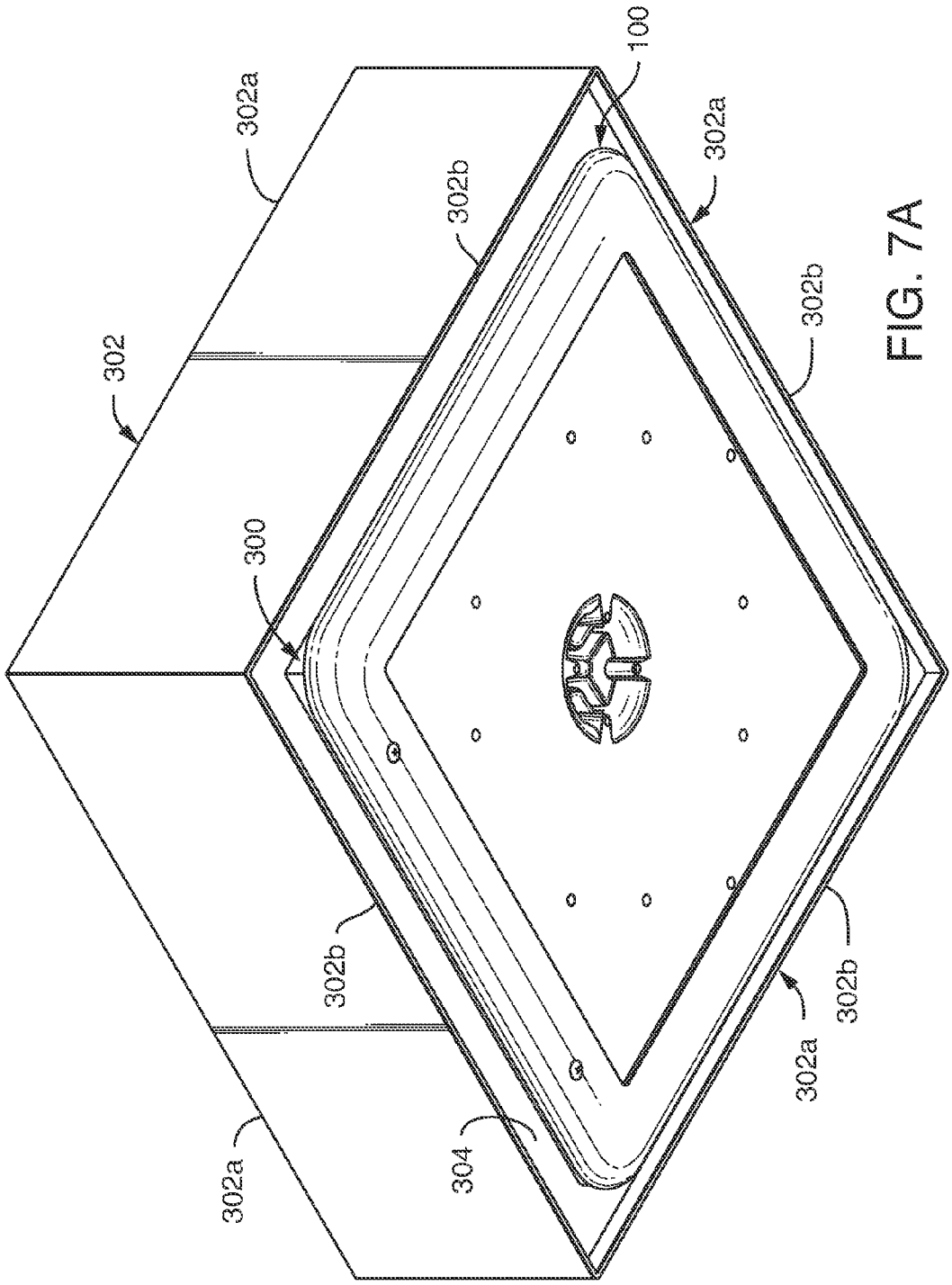


FIG. 7A

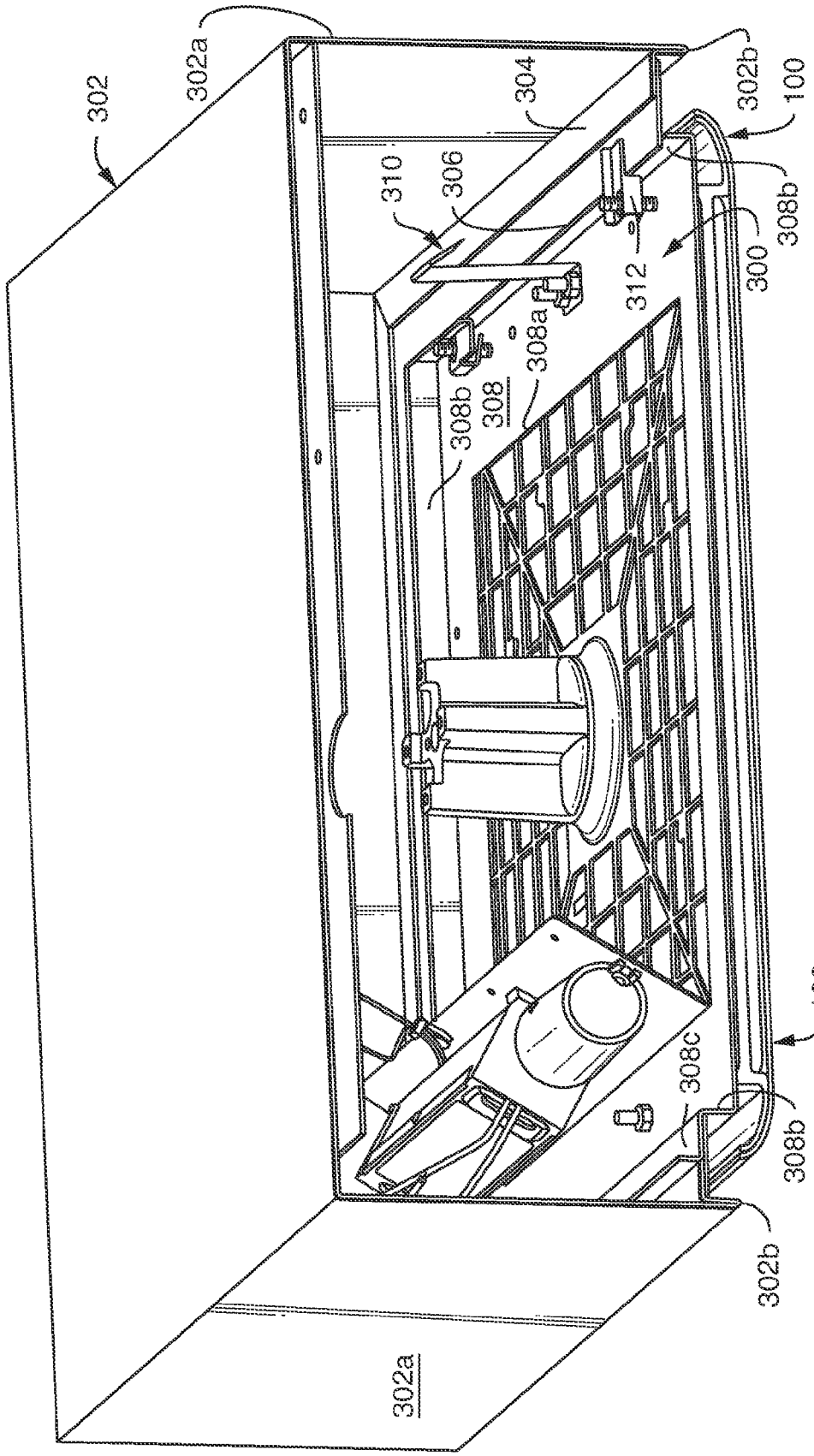
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FIG. 7B

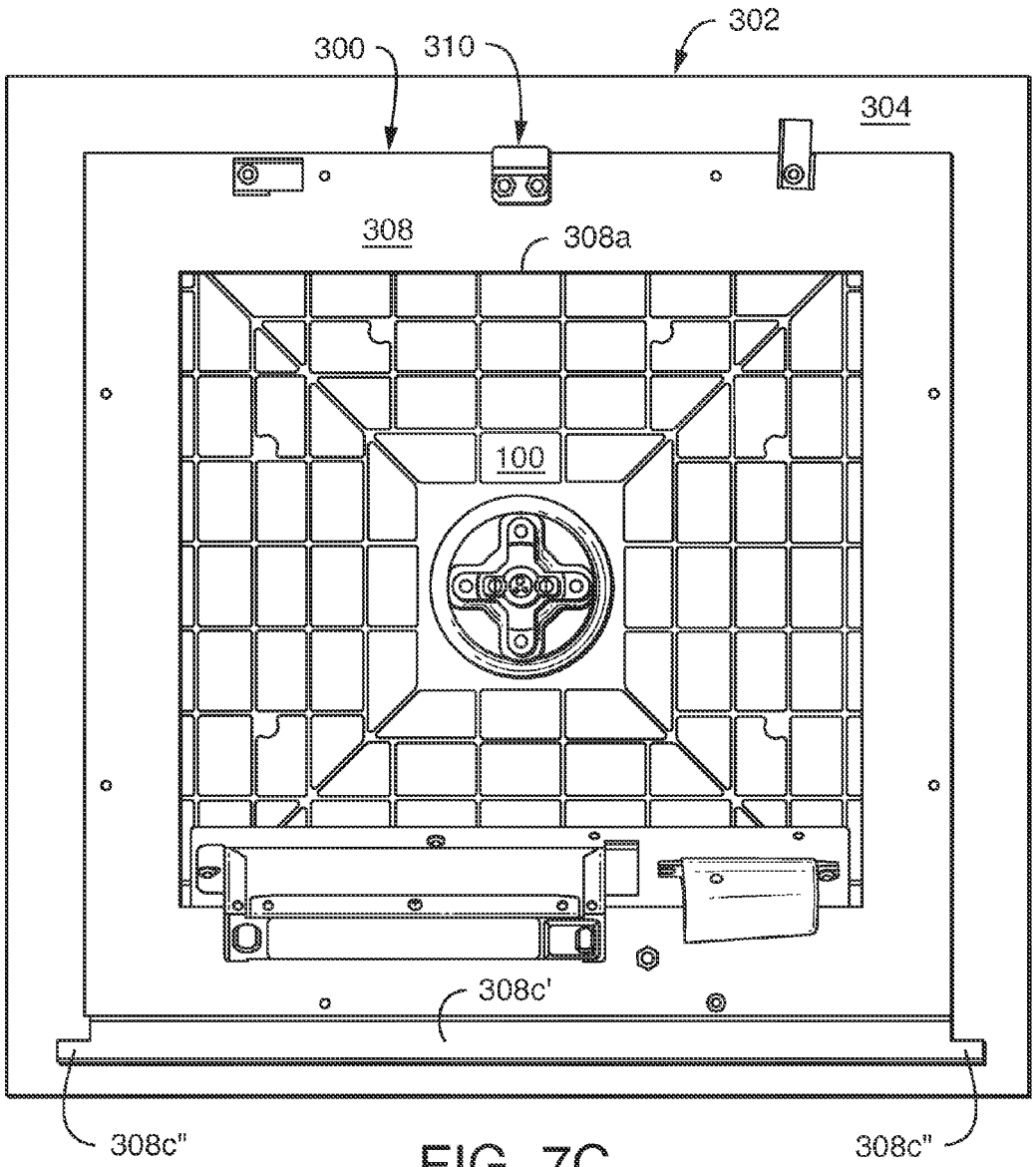


FIG. 7C

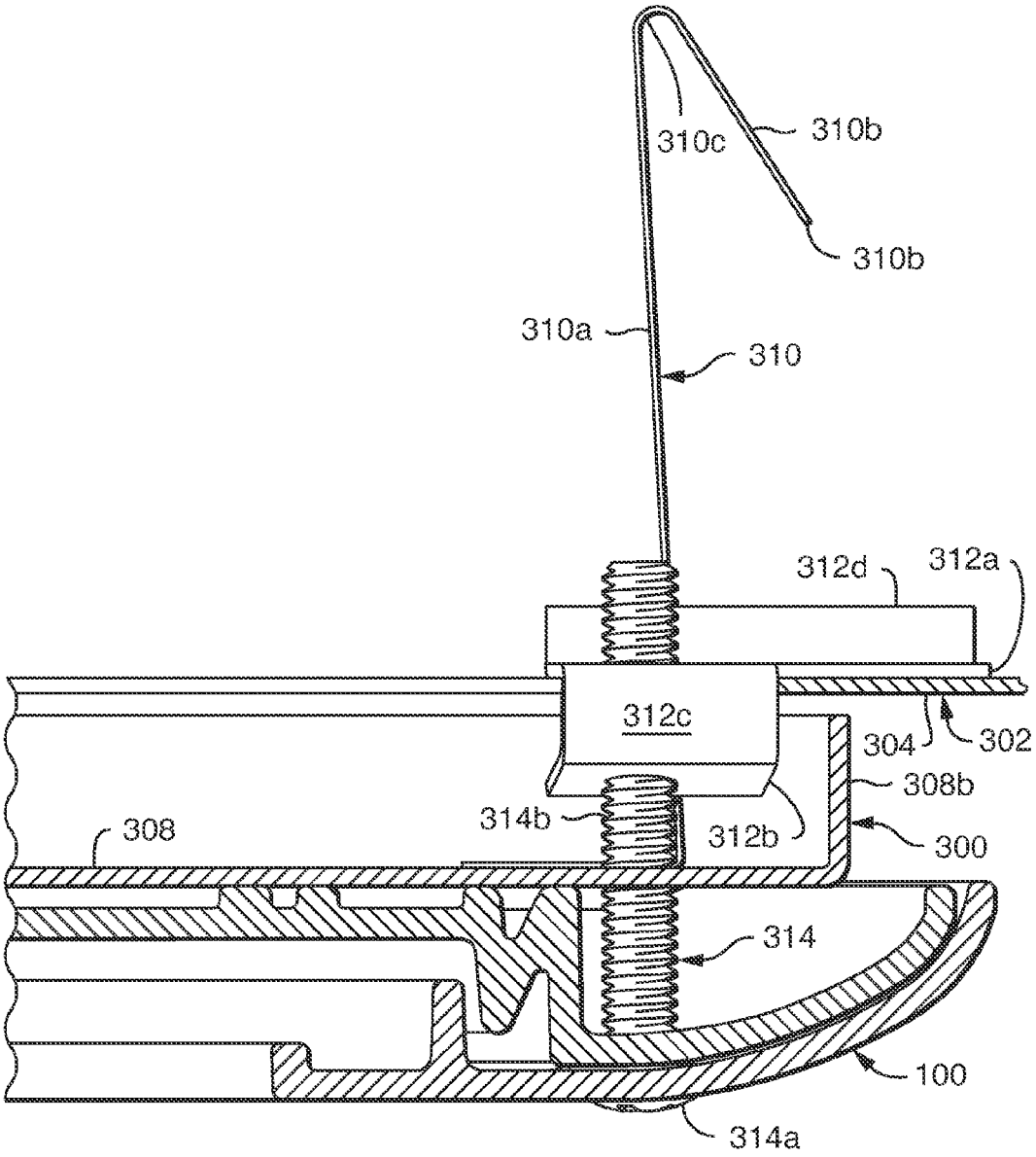
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FIG. 7D

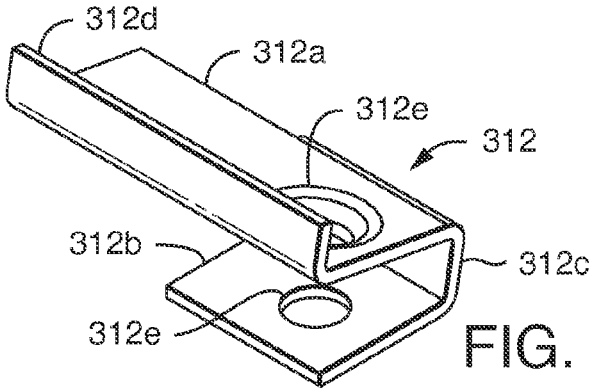
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FIG. 7E

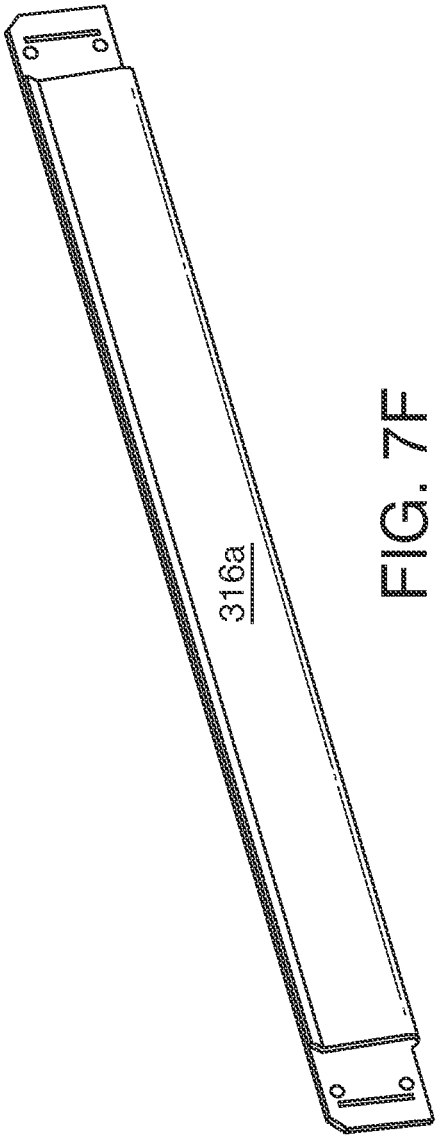


FIG. 7F

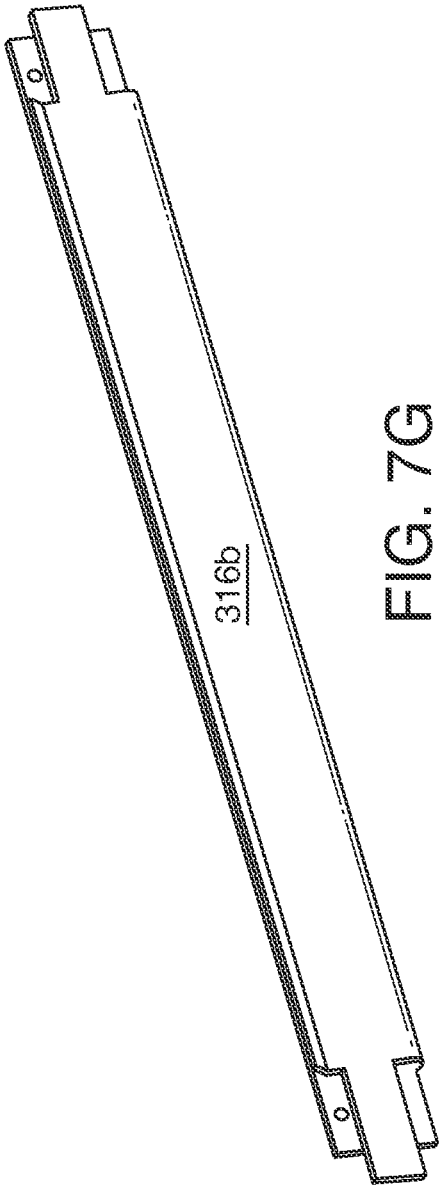


FIG. 7G

# LUMINAIRES AND LUMINAIRE MOUNTING STRUCTURES

This application, and the following patent applications, were all filed on Nov. 5, 2013 as continuation applications of application Ser. No. 13/828,446 filed Mar. 14, 2013 and are all related applications: Ser. No. 14/071,878; 14/071,885; 14/071,897; 14/071,908.

## FIELD OF THE DISCLOSURE

The present disclosure is directed generally to a luminaire for casting light to a target area to be lighted. More particularly the present disclosure is directed to a luminaire constructed from a minimum number of parts and/or with a minimum profile. The present disclosure further relates to a manner of ventilating the inside of a luminaire. The present disclosure also relates to mounting structures to facilitate simple and quick mounting of a luminaire to a pre-existing housing.

## BACKGROUND OF THE DISCLOSURE

There is a need for a luminaire and mounting structure of the type described herein. More particularly, there is a need for a low-profile luminaire capable of providing proper light distribution. There is also a need for a luminaire having a minimum number of parts and capable of providing proper light distribution. Furthermore, there is a particular need for a low-profile luminaire capable of providing proper light distribution and having a minimum number of parts.

## SUMMARY OF THE DISCLOSURE

A luminaire comprising a housing defining one or more mounting holes therein, the mounting holes not threaded; a connector having a head and a shaft, the connector shaft located at least partially in one of the one or more mounting holes, the connector shaft comprised of a pliable material; a circuit board mounted to the housing by the connector head, the circuit board populated with one or more LEDs; and a lens resting against and spaced form the circuit board by the connector head. The connector can define a screw with threads on the connector shaft. The pliable material may be nylon. The circuit board can define holes and the connector shaft can extend through the circuit board holes, the connector head holding the circuit board to the housing. At least one of the mounting holes can be defined in a face of the housing, the housing can further comprise a cylindrical spacer boss extending outward from the housing face extending the at least one mounting hole beyond the face, the circuit board can define at least one hole and the cylindrical spacer boss can be located in the circuit board hole. The housing can comprise a substantially flat plate and the one or more mounting holes can be located in the plate; the plate can define a face; a cylindrical spacer boss can extend outward from the housing face to extend the at least one mounting hole beyond the face, the circuit board can define at least one hole and the cylindrical spacer boss can be located in the circuit board hole. The circuit board can be mounted directly against the housing.

A luminaire comprising a housing; a lens frame comprising a perimeter, an outer trough wall, an inner trough wall and a base extending between the outer trough wall and the inner trough wall, the inner trough wall, base and outer trough wall defining a trough; the outer trough wall being taller than the inner trough wall; an adhesive sealant in the trough; and a lens resting on a distal end of the inner trough wall and contacting the adhesive sealant. The trough can extend around the entire perimeter of the lens. The trough can extend around an inner perimeter of the lens frame. The adhesive sealant can be a urethane. An adhesive sealant can be provided around an outer perimeter of the outer trough wall forming a seal between the housing and lens frame. The outer trough wall can extend higher than the lens.

A luminaire comprising a plurality of LEDs arranged in a matrix at a pitch P; the luminaire is configured to drive each LED to produce L lumens per LED; and a ratio of L to P being between approximately 59.2 lumens/inch and 70.4 lumens/inch; wherein the LEDs provide a combined even glow when illuminated. P can be approximately 0.625 inches. The ratio of L to P can be approximately 59.2 lumens/inch at 530 mA and 70.4 lumens/inch at 650 mA. One of more of the plurality of LEDs can be a 0.25 Watt LED.

A luminaire comprising a housing defining a front side and a rear side; a circuit board mounted to the housing front side; a column extending from the housing rear side to an end, an aperture defined in the column end; and a breathing tube extending through the column aperture. A box can be mounted to the end of the column and the breathing tube can extend into the box. The box can be a driver box housing a driver to power the LEDs. The luminaire can be sealed against ingress or egress of water or air, except for through the breathing tube. The breathing tube can be sealed in the column aperture with a sealant and the breathing tube can be run through the sealant, the sealant preventing ingress of air or water into the housing except through the breathing tube. A sealant filled gland can be secured to the column aperture, the gland filled with a sealant, the breathing tube running through the sealant, the sealant preventing ingress of air or water into the housing except through the breathing tube.

A luminaire comprising a housing defining a front side and a rear side; a circuit board mounted to the housing front side; a column extending from the housing rear side to an end; a box mounted to the end of the column and having a stem extending downward to a lower distal end and accommodating the column within the stem; and the stem defining a groove in the lower distal end for receiving a gasket to create a seal when mounted against a structure when the luminaire is installed in the structure. The box can be a driver box housing a driver to power the circuit board. The structure can be a canopy. The box can be integral with the stem. The box can be mounted to the column.

A mounting apparatus for mounting a luminaire to a mounting structure comprising a face plate defining an aperture, the mounting apparatus comprising: a mounting plate for mounting to the luminaire; the mounting plate having an extension flange; a pair of wings extending from opposing sides of the extension flange for residing within the aperture; and the wings for extending beyond the aperture over the face plate. A driver flange can extend from the mounting plate and a driver mounted to the driver flange for providing power to the luminaire. The mounting apparatus can further comprising a flange for extending upward from the luminaire toward the face plate; a screw having a threaded shaft for extending through the luminaire; and a lock wing mounted on the threaded shaft, the lock wing comprising a lock arm extending a first distance to a distal end and a stop arm extending a second distance to a distal end; the first distance being longer than the second distance; wherein, the lock wing is rotatable by rotation of the screw to rotate the lock arm between a position over the face plate aperture and a position over the face plate. The lock arm and stop arm can be integrally connect by a bridge member. When the lock arm is rotated from over the face plate aperture to over the face plate when rotat-

ing the lock wing in a first direction, the stop arm can contact the flange to prevent the lock wing from continuing rotation in the first direction before the lock arm is rotated back over the face plate aperture.

## BRIEF DESCRIPTION OF THE DRAWINGS

Aspects and embodiments of the present disclosure may be more fully understood from the following description when read together with the accompanying drawings, which are to be regarded as illustrative in nature, and not as limiting. The drawings are not necessarily to scale, emphasis instead being placed on the principles of the disclosure. In the drawings:

FIG. **1**A is a bottom-side perspective view of a luminaire in accordance with the present disclosure;

FIG. **1**B is a top-side perspective view of the luminaire depicted in FIG. **1**A with driver box and stem;

FIG. **1**C is an exploded view of the luminaire depicted in FIG. **1**A with driver box, stem and gasket;

FIG. **2**A is a bottom-side perspective view of a housing of the luminaire depicted in FIG. **1**A;

FIG. **2**B is a top-side perspective view of a housing of the luminaire depicted in FIG. **1**A with the lens frame shown for context;

FIG. **3**A is a top-side perspective view of a lens frame of the luminaire depicted in FIG. **1**A;

FIG. **3**B is an outtake of a portion of the lens frame of FIG. **3**A, with a gasket and adhesive sealant not depicted in FIG. **3**A;

FIG. **4**A is a cross-section of a portion of the luminaire depicted in FIG. **1**A;

FIG. **4**B is a different cross-section of a portion of the luminaire depicted in FIG. **1**A;

FIG. **4**C is yet another different cross-section of a portion of the luminaire depicted in FIG. **1**A;

FIG. **4**D is a cross-section of a portion of the luminaire depicted in FIG. **1**A showing a greater width of the luminaire than FIGS. **4**A-C;

FIG. **4**E is a cross-section of the housing stem of the luminaire depicted in FIG. **1**A populated with wiring and breathing tube;

FIG. **5**A is a bottom side view of the driver box and driver box stem depicted in FIG. **1**B;

FIG. **5**B is an exploded view of the luminaire depicted in FIG. **1**A and the driver box and gasket depicted in FIG. **1**C in the context of installation to a structure;

FIG. **6** is a bottom side view of the printed circuit board of the luminaire depicted in FIG. **1**A;

FIG. **7**A is a bottom-side perspective view of the luminaire depicted in FIG. **1**A mounted in a mounting structure;

FIG. **7**B is a perspective cross-sectional view of the luminaire and mounting structure depicted in FIG. **7**A;

FIG. **7**C is a top side view of the luminaire and portions of the mounting structure depicted in FIG. **7**A;

FIG. **7**D is a cross-sectional view of portions of the luminaire and mounting structure depicted in FIG. **7**A;

FIG. **7**E is a perspective view of a locking wing of the mounting structure depicted in FIG. **7**A; and

FIGS. **7**F and **7**G are perspective views of optional mounting structure extensions of the mounting structure depicted in FIG. **7**A.

The embodiments depicted in the drawing are merely illustrative. Variations of the embodiments shown in the drawings, including embodiments described herein, but not depicted in the drawings, may be envisioned and practiced within the scope of the present disclosure.

## DETAILED DESCRIPTION

Aspects and embodiments of the present disclosure provide luminaires and elements thereof. Luminaires according to the present disclosure can be used for new installations or to replace existing luminaires or elements thereof. Use of such luminaire and lighting elements can afford reduced energy and maintenance as well as reduced installation time and costs when compared to existing techniques. The versatility of the luminaire and elements of the present disclosure also afford efficiencies to manufacturers, installers and end-users of such luminaire through lower manufacturing and inventory costs as well as the ability of the end-user to upgrade, adapt or fix the luminaire in the field.

While the preferred embodiment uses light emitting diodes ("LEDs") as light sources, other light sources may be used in addition to LEDs or instead of LEDs within the scope of the present disclosure. By way of example only, other light sources such as plasma light sources may be used. Further, the term "LEDs" is intended to refer to all types of light emitting diodes including organic light emitting diodes or "OLEDs".

While the luminaire depicted in the Figures is generally applicable to any application that would benefit from indoor or outdoor area lighting, it is well-suited, in one example, for application to canopies and the like such as those used at petroleum refill stations. In other applications, luminaires and mounting structures disclosed herein are applicable to soffits or ceilings.

FIGS. **1**A and **1**B depict bottom-side and top-side perspective views of a luminaire **100**, in accordance with the present disclosure, which is a low-profile luminaire capable of providing proper light distribution and having a minimum number of parts. The luminaire **100** comprises a housing **102**, a circuit board **104** populated with light sources **106** such as LEDs, a plurality of screws **108**, a lens **110**, a gasket **112** and a lens frame **114**. The circuit board **104** can be any known circuit board for properly arranging the light sources **106** and, in one embodiment, can be a printed circuit board ("PCB"). For the sake of simplicity, circuit board **104** will be referred to herein as a PCB, but it will be understood that any type of circuit board is suffice.

The overall shape of the luminaire **100** is depicted as substantially square with rounded corners, but other shapes are contemplated as operating within the scope of this disclosure. By way of example only, rectangular, circular and triangular are all contemplated. Because the overall shape of the luminaire **100** is dictated in the depicted embodiment by the shape of the housing **102** and the lens frame **114**, the shape of the housing **102** and lens frame **114** are likewise contemplated as have these exemplary shapes or others.

The housing **102** comprises a plate **116**, a perimeter **118** and a wall **120** between the face **116** and the perimeter **118**. The perimeter **118** extends about the perimeter of the housing and thus takes the shape of the housing, which in the depicted embodiment, is square with rounded corners, as discussed above. The perimeter **118** defines a front face **118***a* and a rear face **118***b*. The front face **118***a* of the perimeter **118** extends from an inner edge **118***c* to an outer edge **118***d* which defines the outermost perimeter of the housing **102**. The perimeter inner edge **118***c* defines the downward most facing portion of the housing **102**. The front face **118***a* of the perimeter **118** extends from the perimeter inner edge **118***c* to the perimeter outer edge **118***d* forming a curvilinear front face **118***a*. In the depicted embodiment, the curvilinear front face **118***a* initially

extends outward form the inner edge **118***c* in straight horizontal manner, and then curves upward with an ever-increasing radius of curvature to the perimeter outer edge **118***d*. Other curvilinear shapes are contemplated as falling within this disclosure. By way of example only, the front face could extend horizontally to a 90° edge, which then extends upward to the outer edge.

References herein to upward and downward orientation are with reference to the depicted embodiments in which the luminaire **100** is mounted to the underside of a flat structure (such as a ceiling or a canopy) and are for purposes of conveying a description of the elements of the disclosure, but are in no way intended to be limiting. In application, upward can be reoriented downward and downward can be reoriented upward.

The housing perimeter **118** preferably defines one or more locator grooves **122** extending from the perimeter front face upward into the perimeter with a locator groove wall **122***a* to a locator groove base **122***b* that is flat in the depicted embodiments, but can vary, extending horizontally. The locators grooves **122** receive locator bosses **140** on the lens frame **114** to assist in properly locating the lens frame **114** on the housing **102** and, separately, to accommodate a boss from the lens frame **114** which can receive a mounting screw **134** from the groove base **122***b*, which will remain hidden from sight to persons viewing the bottom of the luminaire **100**, in the depicted embodiment. FIG. **4**B depicts a cross-section of a portion of the luminaire **100** through a locator groove **122**, a corresponding locator boss **140** and mounting screw **134**.

In the depicted embodiment, the luminaire **100** defines two locator grooves **122** on each of the four sides defining the square shape of the luminaire **100**. Greater or fewer locator grooves **122** are contemplated. For example, if the locator grooves **122** are used purely for locating the lens frame **114** on the housing **102**, then one, or two would suffice. Alternatively, an embodiment of the luminaire **100** is contemplated with no locator grooves **122**. If, however, the locator grooves **122** are used to accommodate a boss to facilitate mounting the housing **102** to the lens frame **114** by screw, or the like, then the number and location of the locator grooves **112** will be dictated by the size and weight of the lens frame **114** in order to properly secure the lens frame **114** to the housing **102** with sufficient sealing there between, if desired, as discussed below.

The housing plate **116** extends across the housing to fill in the area surrounded by the housing perimeter **118**. The housing wall **120** extends downward from the housing plate **116** just inward of the housing perimeter **118** to a distal end **120***a* and about the entire housing plate **116** as depicted in FIG. **2**A. The housing wall **120** does not extend as far down as the inner edge of the perimeter **118**. Rather, the housing wall **120** extends downward far enough to engage the gasket **112** located in the lens frame **114** as shown in FIGS. **4**A-**4**D and discussed below. In this manner, the wall **120** deforms the gasket **112** forming a vapor and moisture barrier there between. Because the wall **120** and gasket **112** extend about the entire luminaire **100** just inward of the perimeter **118**, a vapor and moisture barrier is formed between areas inward of the wall **120** (e.g. the PCB) and areas outward of the wall **120**. This construction forms a barrier against vapor and moisture that might otherwise ingress between the housing **102** and lens frame **114**. The housing wall **120** can take different forms as seen in FIGS. **4**A-**4**D in order to minimize weight and material while still creating sufficient deformation of the gasket **112** to create desired vapor and moisture barrier.

The housing plate **116** has a front face **116***a* and a rear face **116***b*. The housing plate front face **116***a* is substantially flat, extending across and filling in the perimeter **118**, with the exception of a plurality of mounting holes **124** defined therein and a spacer boss **126** surrounding and extending each mounting hole **124** out beyond the housing plate front face **116***a*. Each spacer boss **126** comprises a cylindrical wall extending downward from the housing plate front face **116***a* to a distal end **126***a* and configured so that an inner wall of the spacer boss **126** continues the inner wall of the corresponding mounting hole **124** so that the spacer boss **126** effectively extends the depth of the mounting hole **124** to a depth B. In the depicted embodiment, the spacer boss distal end **126***a* sits approximately even with a front face **104***a* of the PCB (as depicted in FIGS. **4**A and **4**D), thus acting to space the head of the screws **108** a distance approximately equal to the thickness of the PCB, shown as distance C in FIG. **4**D, to the PCB front face **104***a*. In one exemplary embodiment, distance B can be 0.125 inches, where the distance C can be 0.047 inches. In another exemplary embodiment, height of the spacer bosses **126** is just short of the thickness of the PCB **104** so that the screws **108** not only hold the PCB **104** from falling off the housing **102**, but also hold it steady, preventing rattle of the PCB **104** and creating a heat transfer connection between the PCB **104** and the housing **102** causing the housing **102** to act as a heat sink for the PCB **104** and the LEDs **106** mounted thereon. These objectives are enhanced when the screws **108** are constructed of a pliable material, as discussed below. The height of the spacer bosses **126** could be 0.002 inches shorter than the thickness of the PCB **104** in one embodiment. Other dimensions are contemplated to meet these objectives.

In an alternative embodiment, no spacer bosses **126** are employed. However, the spacer bosses **126** provide two advantages. First, the spacer bosses **126** reduce assembly time by allowing screws **108** to be driven into the mounting holes **124** without regard for when they reach the PCB **104**. Without the spacer bosses **126**, advancing the screws **108** would be conducted with concern about advancing them too far or with too much power, either of which might damage the PCB **104**. The spacer bosses **126** obviate that concern by allowing the screws **108** to be advanced to the spacer boss distal end **126***a* as quickly and efficiently as possible. This ease of securing the screws **108** to the housing **102** without damaging the PCB **108** is further advanced by using screws **108** of a pliable material such as, by way of example only, nylon. Use of such pliable screws **108** will allow the screws **108** to be advanced without regard for exactly when advancement need stop. That is, over advancing the screws **108** will not "strip" the mounting holes **124** or damage the screws **108** to an extent such to prevent them from holding the PCB **104** to the housing **102**. Instead, by using screws **108** of a pliable material, over advancing the screws will slightly deform the threads of the screws **108**, but not so much as to prevent the pliable threads of the screws **108** from grasping the inside of the mounting holes **124**.

Moreover, in the depicted embodiment, the inner wall of the mounting holes **124** is straight (i.e. is not threaded). This further limits production costs by removing the need to tap the mounting holes **124** or create a complicated mold having reliable threads in the mounting hole **124**. Additionally, using straight mounting holes **124** actually allows shallower mounting holes **124** because the use of a typically tap to create the threads in a mounting hole requires a certain depth in order to facilitate the tapping. Using straight holes eliminates the need to be able to tap the mounting holes **124**, thus allowing shorter mounting holes **124** than could otherwise be used. In one exemplary embodiment, the depth B of the mounting holes **124** is 0.125 inches. Furthermore, by using the spacer bosses

126 to extend the wall of the mounting hole 124 out to the face of the PCB 104, the depth of the mounting hole 124 is moved into the luminaire 100, reducing the distance that the mounting hole 124 need extend toward the housing plate rear face 116*b*, thus allowing a thinner overall luminaire 100. Moreover, using pliable screws 108 in straight mounting holes 124 further reduces, or eliminates, the likelihood of damaging the screws 108 by over advancement.

The second advantage provided by the spacer bosses 126 is their inherent ability to reduce tolerances in the stack of elements (housing 102, PCB 104, screws 108, lens 110 and lens frame 114) contributing to the over all height of the luminaire 100, and thus its low-profile. As discussed in greater detail below, tight stack of these element contributes to the low-profile. The ability to advance the screws 108 against the spacer bosses 126 without exception so as to limit the tolerances necessary and contribute to an overall low profile. The additional cost of these spacer bosses is negligible in an embodiment where the housing is cast from a material (e.g. aluminum).

The housing plate rear face 116*b* is also substantially flat, with the exception of a matrix of interconnecting walls 128 extending from the rear face 116*b* a short distance off that face. This matrix 128 increases the overall rigidity of the plate 116 and thus the housing 102. The matrix 128 also provides additional surface area on the rear of the housing 102 to increase the ability of the housing to dissipate heat when any of the matrix 128 is exposed to ambient air. The matrix 128 also assists in providing surface contact with structure to which the housing is mounted when that structure has surface irregularities (i.e. is not flat). This surface contact can also be helpful in directing heat away from the luminaire 100 in installations such as a petroleum refill station canopy which is constructed of sheet metal and much of the sheet metal, except where contacted by the housing, is exposed to ambient air to facilitate transferring to the surrounding air, some of the heat generated by the light sources or utilities for powering the light sources.

The matrix 128 may optionally include bosses 130 at the bottom of the mounting holes 124. These bosses 130 provide additional thickness to account for molding irregularities.

In the depicted embodiment, the housing perimeter rear face 118*b* follows the curvature of the housing perimeter front face 118*a* for the most part. A cross-section of one embodiment is depicted in FIG. 4C. This embodiment keeps the perimeter thin and reduces material usage while the curvature provides structural rigidity. Other shapes and thicknesses are contemplated. The housing perimeter rear face 118*b* also includes the backside of the locator groove wall 122*a* and locator groove base 122*b* protruding therefrom.

As discussed above, one or more of the locator groove bases 122*b* define a screw aperture 132 to accommodate a screw 134 to extend through the housing 102 and into the lens frame 114 to secure the lens frame 114 to the housing 102. In the depicted embodiment, the screw 134 enters from the housing and extends into the lens frame 114 so as to not be visible from the front side of the luminaire 100. A cross-section of this embodiment is depicted in FIG. 4B. Other embodiments are contemplated.

In order to minimize the number of screws 134 necessary for assembly and minimize the corresponding assembly steps, one or more fins 136 may extend across the housing perimeter rear face 118*b* to fill in the back side of the housing perimeter 118 curvature and provide the housing perimeter 188 with added structural rigidity. In the depicted embodiment, each side of the square housing comprises a single such fin 136 between the two screws 134 and one such fin 136 at each rounded corner of the housing perimeter 118. A cross-section of this embodiment is depicted in FIG. 4A. Other embodiments are contemplated.

The lens frame 114 defines a front face 114*a* and a rear face 114*b* and comprises a lens frame perimeter 136 at the outermost perimeter of the lens frame 136 and a trough 138 defined by an inner trough wall 138*a* and outer trough wall 138*b*. The contour of rear face 114*b* of the lens frame perimeter 136 follows the contour of the housing perimeter front face 118*a*, extending to a distal end 136*a* that lies in approximately the same horizontal plane as the housing perimeter outer edge 118*d*. References herein to a "horizontal" plane are by way of describing relationships between elements and portions of elements in the disclosed luminaire 100 and the term "horizontal" is used because the luminaire 100 is described as being mounted to a ceiling or the like. Use of the term "horizontal" is not limiting on the luminaire 100 as it could be rotated to be mounted in any orientation. By extending the lens frame perimeter distal edge 136*a* to the housing perimeter outer edge 118*d*, the lens frame can cover the housing perimeter 118 from view to provide the luminaire 100 a simple and elegant aesthetic look as seen in FIG. 1A. One of more locator boss 140 extends rearward from the lens frame rear face 114*b* into the curvature defined by the lens frame perimeter 136. As described above, the locators grooves 122 of the housing 102 receive the locator bosses 140 to assist in properly locating the lens frame 114 on the housing 102 and, separately, to receive the mounting screw 134, which will remain hidden from sight to persons viewing the bottom of the luminaire 100, in the depicted embodiment. FIG. 4B depicts a cross-section of a portion of the luminaire 100 through a locator groove 122, a corresponding locator boss 140 and mounting screw 134. The lens frame 114 is oriented vertically at the distal edge 136 and then curves downward and inward with an ever increasing radius of curvature the farther it is from the distal edge 136 until it is oriented approximately horizontal where it is adjacent to the housing perimeter inner edge 118*c*.

A base 138*c* of the lens frame trough 138 continues to extend inward from the lens frame perimeter 136 horizontally and seamlessly from the lens frame perimeter 136. Other embodiments are contemplated. The lens frame trough inner trough wall 138*a* then extends vertically to define the lens frame innermost perimeter which defines a lens frame aperture 142 through which light emitted by the light sources 106 passes to leave the luminaire 100.

Gasket 112 is located about the perimeter of the trough outer wall 138*b* (depicted in FIG. 3B and FIGS. 4A-4D, but not FIG. 3A), which holds the gasket 112 in place during assembly. When the housing 102 and lens frame 114 are brought into alignment with, and secured one to the other, the housing wall 120 contacts and deforms the gasket 112. In the deformed state, the gasket 112 forms a seal against ingress of vapor, moisture, water or dirt between the housing 102 and the lens frame 114. The gasket 112 extends around the entire perimeter of the outer trough wall 138*b* and the housing wall 120 extends around the entire housing 102 such that the seal formed between the housing wall 120 and the gasket 112 extends about the entire perimeter of the PCB 104 preventing ingress of vapor, moisture, water or dirt between the housing 102 and the lens frame 114 that could reach the PCB 104 or other portions of the luminaire 100 within that perimeter seal. In an alternative embodiment, a urethane sealant could be substituted for the gasket 112. For the sake of efficiency, this urethane adhesive could be the same urethane adhesive as used in the trough 138, as discussed below.

The trough inner wall **138***a* extends upward a distance A (FIG. **40**) from the trough base **138***c* to a distal end on which the lens **110** rests. The lens **110** is sized so as to rest on the trough inner wall **138***a* distal end and extend almost all of the way to the trough outer wall **138***b*, leaving at least sufficient space there between to ease assembly. The trough outer wall **138***b* extends upward from adjacent the lens frame perimeter **136** and upward beyond the lens **110**. The trough inner wall **138***a* is therefore shorter than the trough outer wall **138***b*. An adhesive sealant **144** is deposited into the trough **138** during assembly in a bead having a height sufficient so that when the lens **110** is placed on top of the bead, the lens **110** will deform the bead of adhesive sealant **144** until the lens **110** contacts and rests on the tough inner wall **138***a* distal end. The height of the trough inner wall **138***a* is a height A, and is designed to prevent the lens **110** from squeezing all of the adhesive sealant **144** out from between the lens frame **114** and lens **110** by limiting the distance between the lens **110** and the trough base **138***c* to height A. In this manner, the deformed bead of adhesive sealant **144** will have sufficient height to provide adhesion between the lens **110** to the lens frame **114**. In one exemplary embodiment, the height A is 0.094 inches when using a 0.225 inch diameter bead of a urethane adhesive (SikaTack®-Ultrafast, sold by Sika Corporation, in one embodiment). In this embodiment, it has been found that the bead compresses to approximately the height A and approximately 0.425 inches, providing sufficient surface area to adhere to the lens **110**. Other heights A, bead diameters and adhesive sealants are contemplated.

As depicted in FIGS. **4**A-**4**D, the lens **110** in the assembled luminaire **100**, is held by inner trough wall **138***a* and forced into contact with the head of the screws **108**. In this depicted embodiment of the luminaire **100**, the head of one or more of the screws **108** is sized (height of D) to facilitate this contact between the heads of the screws **108** and the lens **110**. This contact holds the screws **108** in the mounting holes **124** and eliminates the need for any holding force between the screws **108** and the mounting holes **124** once the luminaire **100** is assembled. The need for only short term holding force between the screws **108** and mounting holes **124** can further reduce the requirements of the mounting hole **124** and the screws **108** allowing them to be even shorter and allowing an even thinner overall luminaire. The short term requirement for this holding force can also reduce the requirements of screws **108**, reducing the overall cost of the luminaire **100**. In one exemplary embodiment, the height of the screws is just sufficient to prevent the screws **108** from backing off the force with which they press on the PCB **104**. In an alternative exemplary embodiment, the lens **110** increases the force with which the screws **108** press on the PCB **104**. In one exemplary embodiment, the height D of the head of such screws **108** is 0.190 inches. Alternative embodiments are also contemplated in which the screw **108** is not held by the lens **110** or are rivets through the PCB **104** and through a hole (not depicted) in the housing **102**. Other attachment hardware is also contemplated.

The PCB **104** comprises a PCB front face **104***a* populated with LEDs **106** and a PCB rear face **104***b*. The PCB rear face **104***b* is pressed into contact with the housing **102** by the screw **108** to create sufficient contact between the PCB **104** and the housing **102** to allow the housing **102** to act as a heat sink, taking away heat generated by the LEDs **106** and associated circuitry.

With the exception of the LEDs **106**, the PCB front face **104***a* is covered with a reflective coating or covering. In one exemplary embodiment, the PCB front face **104***a* is covered with a white adhesive paper adhered to the PCB front face **10***a*. In another embodiment, the PCB front face **104***a* is covered with a sheet of reflective aluminum not depicted). The reflective coating or covering covers the PCB from view while, at the same time, redirecting light off of e PCB front face **104***a* rather than absorbing it. Many luminaires, especially those using LEDs, place reflectors or optics near the light sources to redirect light emitted from the light sources to travel out of e luminaire. When using this reflective coating or covering discussed above, the luminaire of the present disclosure does no use any such reflectors or optics. The absence of reflectors and optics allows the distance between the PCB **104** and the lens **110** to be set as low as desired, bounded only by the need to secure the PCB **104** to the housing **102**. In this annex the absence of any reflectors or optics further contributes to a thin (i.e. low-profile) luminaire **100**.

In order to further reduce the overall height of the luminaire **100**, the light sources are LEDs **106** comprised of 0.25 Watt LEDs rather than larger, more powerful LEDs. Historically, one challenge of using LEDs for area lighting has been that LEDs have traditionally emitted insufficient light to replace more conventional light sources such as incandescent or fluorescent. This deficiency has traditionally been overcome by the use of a matrix of LEDs. However, as the acceptance of LEDs for area lighting has become more accepted, technologies have been driven to increase the lumen output LEDs. As the technologies have advanced in this manner, conventional thinking in the LED lighting industry has been to use the biggest and brightest LEDs available for area lighting. The luminaire **100** of the present disclosure takes advantage of the advances in technology, but bucks traditional thinking by using a larger number of smaller, low output LEDs **106** as opposed to a larger number of larger, higher lumen output LEDs. The use of these smaller, low output LEDs **106** provides the luminaire **100** two advantages.

First, many manufacturers currently manufacture and sell 1 Watt LEDs. For example, Nichia sells the NS9W383 1 Watt LED. This 1 Watt LED has a height of approximately 0.108 inches. Instead of using these, or other, 1 Watt LEDs, the LEDs **106** used by the luminaire **100** are 0.25 Watt LEDs. In one exemplary embodiment the LEDs **106** are Nichia NS2W757A LEDs. More LEDs **106** are required to provide the luminaire **100** the same lumen output than would be necessary if the 1 Watt LEDs were used. However, the 0.25 Watt LEDs **106** reduce the height of the LEDs by 0.086 inches, allowing further reduction in the overall height of the luminaire **100**.

In one embodiment of the disclosed luminaire depicted in FIG. **6**, the PCB **104** is populated with 460 Nichia 0.25 Watt NS2W757A LEDs arranged in a matrix spacing them at a pitch of 0.625 inches. When driven at 530 mA, these 460 LEDs emit approximately 37 lumens each for a total of approximately 17,000 lumens. When driven at 650 mA, these 460 LEDs emit approximately 44 lumens each for a total of approximately 20,240 lumens.

Second, it has been found that the larger number of lower Watt and lumen LEDs **106** provide a more even light distribution that is more pleasant to the eye. This more even glow can be expressed as a ratio of the lumens (L) per LED **106** to the pitch (P) of the LEDs **106**. In the embodiments disclosed in the preceding paragraph, each of the 460 LEDs are spaced at a pitch P of 0.625 inches. When these LEDs are driven at 530 mA they produce approximately 37 lumens each for a ratio of 59.2 lumens/inch. When these same LEDs are driven at 650 mA they produce approximately 44 lumens each for a ratio of 70.4 lumens/inch. Other lumen outputs per chip and pitches are acceptable. It has been found that a L/P ratio of between approximately 59.2 lumens/inch and approximately

70.4 lumens/inch provide a combined even glow when the 0.25 Watt LEDs are illuminated. This ratio is contemplated as applicable to LEDs of other small wattage.

The accumulation of the above discussed advantages of the disclosed luminaire **100** result in an overall thin (i.e. low profile) luminaire **100**. With the height E between the rear of the housing **102** and the housing plate front face **116***a* (0.193 inches in one exemplary embodiment) minimized to the thickness of a plate necessary for molding the mounting holes **124** in the housing plate front face **116***a* and the matrix **128** on the housing place rear face **116***b*, the height E can be less than 0.2 inches and it has been found that a height of 0.193 inches is optimal. Furthermore, use of pliable screws **108**, with straight mounting holes **124**, spacer bosses **126**, thin LEDs **106** and a lens frame trough **138** having an inner trough wall **138***a* working in conjunction with the screws **108** to precisely control the height of the lens **110** with respect to the PCB **104** and the lowermost extremity of the lens frame aperture **142** creates a high precision, low tolerance stack of parts that facilitate a precisely thin luminaire **100** that eliminates the need for secondary reflectors or secondary optics in addition to the refractive optic built-in with the LED and/or the reflective front face **104***a* of the PCB, thus further reducing the thickness of the luminaire **100**. Because the only optics in the luminaire are those built-in with the LEDs, the luminaire does not comprise any one optic associated with more than one LED. The height F between the housing plate front face **116***a* and the lowermost extremity of the lens frame aperture **142** (0.510 inches in one embodiment) is thus minimized and in conjunction with the minimized height E, provides an overall low profile, highly efficient luminaire **100**. In the exemplary embodiment of height E being 0.193 inches and height F being 0.510 inches, the total height of the luminaire is only approximately 0.703 inches and is facilitated by one or more of the above discussed features.

The low height F, minus the low height C of the PCB **104** provides a very low height between the base of the LEDs **106** and the lowermost extremity of the lens frame aperture **142** through which light rays emitted from the LEDs **106** escape the luminaire **100**. This resulting low height allows most of the lumens emitted from the LEDs **106** to escape the luminaire **100** without need for secondary reflectors or optics. In the example identified above using 460 Nichia 0.25 Watt NS2W757A LEDs driven at 650 mA to emit a total of 20,240 lumens, it has been found that of the 20,240 emitted lumens, 20,195 escaped the luminaire **100** in this configuration.

In one embodiment of the disclosed luminaire, a driver column **146** extends upward from the rear of the housing plate **116**. The driver column **146** may be integral with the housing plate **146** or not integral. In the depicted embodiment, the driver column **146** is integrally cast as part of housing **102**. The driver column **146** comprises four wings **148** extending radially from a central axis of the driver column **146**. The driver column **148** could comprise greater or fewer wings **148**; three in one exemplary embodiment. Each wing **148** extends upward from the housing plate **116**, having opposing lateral walls **148***a* and a circumferential wall **148***b* at the circumferential perimeter of the driver column **146**. In the exemplary depicted embodiment, the circumferential wall **148***b* extends approximately tangential to the circumference of the driver column **146** and the opposing lateral walls **148***a* extend approximately perpendicular to the circumferential wall **148***b* inward generally toward the central axis of the driver column **146**. The entire driver column **146**, including the wings **148**, are depicted as hollow, which is a result of the cost savings available by producing the housing **102**, including the driver column **146** as an integral, unitary casting. Other embodiments are contemplated, however. For example, the wings could be solid and/or secured to the housing in an alternative embodiment.

Each wing **148** defines a mounting boss **150** at its top **152** for receiving fixing hardware for mounting a driver box **200** to be associated with the luminaire **100** during installation. In the depicted embodiment, the mounting boss defines a screw hole **154** for receiving a screw, but other fixing hardware is contemplated in the alternative. The mounting boss **152** is limited to the outer portion of each wing **148**, leaving a recessed land **156** defined by the four mounting bosses **152**.

An aperture **158** is defined at the center of the driver column **146** through the land **156** to allow utilities to pass from the luminaire **100** to the driver box **200**. For example, wiring **160** to provide power to the light sources passes through the aperture **158** to deliver power from a driver located in the driver box **200** to the light sources.

In an exemplary embodiment, the aperture **158** is designed to allow air to pass therethrough, even when the wires **160** are present. Air expands and contracts as it is heated and cooled, respectively. As discussed above, the seal created by gasket **112** seals the air in the portions of the luminaire **100** inward of the gasket from the ambient environment. Thus sealed, the expansion and contraction of this sealed air would create air pressure above or below the ambient air pressure unless that sealed air was somehow vented. If the air pressure of this sealed air were to fall below the ambient air pressure, then the luminaire **100** would tend to try to draw air outside the luminaire, along with any dirt, moisture, etc. into the luminaire. Over time, this could tend to break down the seal created by the gasket **112**. Allowing air to pass through the driver column aperture **158** allows the luminaire **100** to breath and prevents the luminaire **100** from trying to draw moisture across the seal created by the gasket **112**.

In one particular exemplary embodiment of the luminaire **100**, a breathing tube **162** is run through the aperture **158** along with the wiring **160** and a sealant **164** fills the remainder of the aperture **158** so that no moisture, air, dirt, etc. can pass through the aperture unless through the breathing tube **162**. In one embodiment, the sealant **164** is the same urethane adhesive discussed above. In another embodiment, the sealant **164** is an elastomer. Other sealants **164** are contemplated. In yet another exemplary embodiment, a cylindrical gland **166** having a sealant **164** therein is screwed into threads formed in the aperture **158** and the breathing tube **162** and wiring **160** are run through the sealant **164**, which forms a tight seal around the breathing tube **162** and wiring **160** to prevent ingress of any dirt, moisture, air, etc. into the luminaire **100**. The gland **166** could be a commercially available liquid tight fitting for individual conductors such as a Conta-Clip brand model PG9, in one example. Other embodiments are contemplated. Regardless of how the sealant **164** is provided, the breathing tube **162** is run into the driver box **200** to prevent rain water, dirt, etc. from entering the breathing tube **162** and running down into the luminaire **100**.

The driver box **200** comprises a box having a bottom wall **200***a* and perimeter walls **200***b* creating an upwardly open box. The driver box **200** is closed by a cover plate **202** having a central plate **202***a* and downwardly depending edges **202***b* along each side of the central plate **202***a* to direct water, snow, etc. downward past the opening to the driver box **200**. In one exemplary embodiment, the central plate **202***a* extends outward beyond each wall **200***b* of the driver box to further prevent water, snow, etc. from entering the driver box. The driver box comprises mounting hardware to facilitate securing the cover plate **202** to the driver box **200**. In one embodiment, the driver box **200** comprises driver box ears **200***c*

extending from one or more driver box walls **200***a* and defining a hole therein to receive a screw for securing the cover plate **202** to the driver box **200**. In the depicted embodiment, driver box ears **200***c* extend from two opposing ones of the driver box walls **200***a*. By extending the driver box ears **200***c*, and thus the hole in the cover plate **202** to accommodate the screws, outward beyond the driver box walls **200***a*, any rain, snow, etc. falling through the hole in the driver box cover plate **202** will fall outside of the driver box **200** rather than into the driver box **200**. In one possible embodiment, the driver box ears **200***c* do not extend as high as the driver box walls **200***a*, but fall just short thereof. This prevents any water that may fall through the screw holes in cover plate **202** from traveling across the driver box ears **200***c* and into the driver box. Alternatively, the driver box ears **200***c* may extend as high as the driver box walls **200***a*, but have a groove extending across the driver box ears **200***c* between the screw holes and the driver box wall **200***a*.

A stem **204** extends downward from the driver box bottom wall **202***a*. In the exemplary depicted embodiment, the stem **204** is integrally cast with the driver box **200**, but other options are contemplated. The stem **204** is configured to slide over the driver column **146** of the luminaire and accommodate the driver column **146** within the stem **204**. In one embodiment, the stem comprises a wall **204***a* having an inner surface defining an opening **204***b* to receive the driver column **146**. A top **204***c* of the opening **204***b* may be defined by the driver box bottom wall **202***a* (as in the depicted embodiment) or by a separate top **204***c*. The opening top **204***c* can be shaped to complement all or portions of the top of the driver column **146** so that the driver box **200** will sit securely on the driver column **146**. The stem opening top **204***c* defines a utilities aperture **204***d* to accommodate the wiring **160** and the breathing tube **162** and gland **166**, where present, allowing them to enter the driver box **200**. The breathing tube **162** need only enter the driver box **200** and be protected from the elements by the driver box **200** and cover plate **202**. The wiring **160** enters the driver box **200** through the utilities aperture **204***d* and is connected to a driver (not depicted) for providing power to the light sources. One or more hardware apertures **204***e* are defined in the top **204***c* and configured to allow screws or the like to pass through and secure into a corresponding one of the screw holes **154** on the driver column **146** to secure the driver box **200** to the driver column **146** and, thus, the luminaire **100**.

In one embodiment, the stem wall **204***a* defines a lower edge **204***f* and a groove **206** about the entirety of the lower edge **204***f*. The groove **206** accommodates a gasket **208**. In the depicted embodiment, the stem wall **204***a* is cylindrical and the groove **208** and corresponding gasket **208** are circular. Other embodiments are contemplated.

During installation to a structure **210**, the housing **102** is elevated to the structure and the driver column **146** passed through an aperture **210***a* in the structure. The structure **210** could be, by way of example only, a ceiling or a canopy for a petroleum refill station. The structure aperture **210***a* could be a pre-existing aperture left over from a previously installed luminaire or it could be a newly constructed aperture. The gasket **208** rests in the groove **206** defined by the stem wall lower edge **204***f* and becomes compressed when brought into contact with the structure and the stem **204** tightly secured to the driver column **146**. When in this compressed state, the gasket **208** forms a seal around the structure aperture **210***a* to prevent material above the structure (e.g. dirt, water, etc.) from getting to the structure aperture **210***a*. The ability of the gasket **208** to prevent material from getting to the structure aperture **210***a* in this manner is predicated on the gasket **208** and the groove **206**, in which is resides, being larger than the structure aperture **210***a*. In one exemplary embodiment, the stem wall **204***a* is sized to allow the gasket **208** to circumscribe at least a 4 inch diameter structure aperture **210***a*, which is commonly left behind by pre-existing luminaires. Other dimensions are also contemplated. While this size stem is larger than necessary for some applications, it has also been found that the large size of the stem also assists in providing stability of the structure **210** when the structure is somewhat flexible, such as in a sheet metal canopy as is often found at a petroleum refill station.

The stem **204** is preferably of a height to elevate the driver box **200**, or portions thereof, above the height where water, snow, etc. may be allowed to accumulate. For example, a sheet metal canopy a petroleum refill station will often accumulate some water and/or snow during precipitation before that water is directed off the canopy. The height of the stem is preferably designed so that the driver box **200** is above the height to which water and/or snow are likely to accumulate. In this embodiment, the driver within the driver box **200** is more likely to be kept dry than if the stem places the driver box **200** below that height.

A mounting apparatus **300** is depicted in FIGS. **7**A-**7**G which can be used with the luminaire **100** described above, or with a different luminaire. For continuity, the mounting apparatus **300** of the present disclosure will be described in conjunction with the luminaire **100** previously described herein. The mounting apparatus **300** is beneficial in mounting a luminaire, such as luminaire **100**, to a mounting structure **302**, which may depend from another structure such as a ceiling or the canopy of a petroleum refill station.

The mounting structure **302** comprises four walls **302***a* forming a rectangular box, square in the depicted embodiment. The mounting structure **302** further comprises a face plate **304** extending between the four walls **302***a* slightly above their lower distal ends **302***b*. The face plate **304** lies generally horizontal and defines a face plate aperture **306**. The face plate **304** can be separate from the walls **302***a* or extend integrally from the walls **302** as depicted in FIG. **7**B. The mounting structure **302** can be a pre-existing mounting structure in which a different luminaire had been installed or can be newly constructed for installation of a luminaire such as the luminaire **100**. However, the mounting assembly **300** finds particular use for installing modern LED-based luminaires (such as luminaire **100**) in mounting structures such as mounting structure **302** which is typical for housing older model luminaires such as HID or incandescent luminaires.

The mounting apparatus **300** comprises a mounting plate **308** mounted to the back of a luminaire, such as luminaire **100**. The mounting plate **308** optionally defines a mounting plate aperture **308***a* to allow portions of the luminaire to project through. In the depicted example, the driver column **146** of the previously described luminaire **100** is allowed to project through the mounting plate **308** due to the aperture **308***a*. Flanges **308***b* extend upward from each edge of the mounting plate **308** a short distance to contact, or come close to contacting, the mounting structure **302** when installed. A hinge flange **308***c* extends from a first of the flanges **308***b* and comprises an extending portion **308***c*' and wings **308***c*" extending from opposing sides of the extending portion **308**". The extending portion **308***c*' does not extend to the ends of the first of the flanges **308***b*, but instead leaves clearance on both ends. The wings **308***c*" extend beyond the ends of the first of the flanges **308***b* and beyond the edges of the corresponding aperture **306** of the mounting structure face plate **304**. In this configuration, the luminaire (such as luminaire **100**) may hang from the mounting structure **302** by the wings **308***c*" and

may rotate about those wings **308***c*". The clearance left on both ends of the extending portion **308***c*' provides clearance between the extending portion and the edges of the corresponding aperture **306** during rotation. During installation, this structure allows an installer to connect the wiring of the luminaire to the power source in the mounting structure **302**. The mounting plate **308** can be mounted to the luminaire by screws or other hardware.

A catch **310** optionally extends from the mounting plate **308** adjacent to a second of the flanges **308***b* extending from the mounting plate **308** on a side opposite to e first of the flanges **308***b* from which the hinge flange **308***c* extends. The catch **310** comprises a stem **310***a* and a hook **310***b* extending from the flange. In the depicted embodiment, stem **310***a* is mounted to the mounting plate **308** and extend upward to a stem distal end **310***c*, while the hook **310***b* extends downward from the stem distal end **310***c* angled toward the face plate **302** and extending to a hook distal end **310***d* that lies outside of the face plate aperture **306** such that when the luminaire **100** is rotated downward from the mounting structure **302**, the hook catches the face plate **304** and prevents the luminaire **100** from rotating further. A person seeking to rotate the luminaire **100** further may bend the stem **310***a* inward a distance sufficient to allow the hook distal end **301***d* to pass the face plate **304**. When rotating the luminaire **100** into the mounting structure, the angle of the hook **310***b* causes the stem **310***a* to deflect inward as the hook **310***b* slides past the face plate **304**, allowing the hook **310***b* to pass the face plate **304** and spring back to an unbiased position after passing the face plate **304**. While the mounting apparatus **300** is beneficial without the optional catch **310**, the catch **310** is preferable for the above discussed benefits. Other embodiments of a catch are also contemplated.

One or more lock wings **312** are optionally mounted to one lock screw **314** each, which extends vertically through the luminaire **100** and the mounting plate **308** at a location adjacent to the second of the flanges **308***b* extending from the mounting plate **308** on a side opposite to the first of the flanges **308***b* from which the hinge flange **308***c* extends. In the depicted embodiment, the mounting apparatus **300** comprises two lock wings **312**, each mounted to one lock screw **314**. Each lock screw **314** comprises a head **314***a* located at the face of the luminaire **100**, making the head **314***a* accessible when the mounting apparatus **300** is in the closed position depicted in FIGS. **7**A, **7**B and **7**D (i.e. fully mounted to the mounting structure **302**). The lock screw **314** also comprises a threaded shaft **314***b* extending through the luminaire **100**, through the mounting plate **308** and far enough above the mounting plate **308** such that it extends above the mounting structure face plate **304** when the mounting apparatus **300** is in the closed position.

Each lock wing **312** comprises a lock arm **312***a* and a stop arm **312***b* connected by a bridge member **312***c*. In the depicted embodiment, the lock wing **312** is constructed of sheet metal bent into a U-shaped configuration in which the lock arm **312***a* constitutes one leg of the U, the stop arm **312***b* constitutes the other leg of the U and the bridge member **312***c* constitutes the base of the U. In the depicted embodiment, an optional strengthening flange **312***d* extends along and perpendicular to the lock arm **312***a* to provide structural rigidity to the lock arm **312**. Each of the lock arm **312***a* and the stop arm **312***b* define a screw aperture **312***e* for allowing the screw shaft **314***b* to pass through. Optionally, one or both of the screw apertures **312***e* is threaded so that the lock wing **312** can be threaded onto the screw shaft **314***b*. Alternatively, or in addition, the lock wing **312** can be mounted to the screw shaft **314***b* by other means, such as, by way of example only, adhesive.

Each lock wing **312** is mounted on the screw shaft **314***b* at a distance from the screw head **314***a* that will locate the lock arm **312***a* slightly above the mounting structure face plate **304**. In this configuration, each lock wing **312** can be rotated about the central axis of its corresponding screw **4** by, rotating the screw head **14***a* of the corresponding screw **314**. Rotating the lock wing **312** can bring the lock arm **312***a* over the mounting structure ace plate **304** or over the aperture **306** defined in the mounting structure face plate **304**. When the lock arm **312***a* is over the mounting structure face plate **304**, the lock arm **2***a* prevents the luminaire **100** from rotating about the wings **308***c*" of the hinge flange **308***c*, thus keeping the luminaire **100** secure to the mounting structure **302**. However, when the lock arm **2***a* is over the aperture **306** defined in the mounting structure face plate **304**, the luminaire **100** may freely rotate about the wings **308***c*" of the hinge flange **308***c*, thus allowing access to the luminaire **100** or removal of the luminaire **100** from the mounting structure **100** (with the above described manipulation of the optional catch **310**, if present). In this configuration, locking and unlocking the luminaire **100** to the mounting structure **302** requires only a ninety degree (90°) rotation of the screw head **314***a*. The stop arm **312***b* assists a person seeking to lock the luminaire **100** to the mounting structure **302** by contacting the adjacent mounting plate flange **308***b* before the lock arm **312***a* has rotated too far. In this manner, the stop arm **312***b* stops rotation of the lock wing **312** at the appropriate location so that it does not continue rotation and end up over the face plate aperture **306**. In the embodiment in which one or more of the screw apertures **312***e* of the lock wing **312** are threaded to the screw shaft **314***b*, the stop arm **312***b* prevents rotation of the lock wing **312** and continued advancement of the screw **314** would draw the lock wing **312** closer to the screw head **314***a* drawing the luminaire **100** closer to the mounting structure face plate **304**, allowing a person to tighten the luminaire **100** up against the mounting structure face plate **304**, or leave an gap there between at the option of the person. FIG. **7**B depicts one lock wing **312** in the locked position and one lock wing **312** in the unlocked position. Other configurations and operations of the lock wings **312** are contemplated.

Optionally, the driver and/or other utilities can be mounted to the mounting plate **308**. In the depicted exemplary embodiment, the mounting plate **308** comprises a driver flange **308***d* extending upward from the mounting plate and the utilities are attached thereto. By extending the driver flange **308***d* upward of the mounting plate, the driver is separated from the luminaire housing to remove the heat of the utilities from the housing. The driver flange **308***d* may also act as a heat dissipation fin to dispel heat from the luminaire housing into the mounting apparatus **300**.

FIGS. **7**F and **7**G depict optional mounting structure extensions **316***a*, **316***b* that may be mounted to the inner edge of the mounting structure face plate aperture **306** to extend the edges of that aperture **306** inward if slightly larger than desired for an appropriate fit with the mounting apparatus **300**. In operation, the mounting structure extensions **316***a*, **316***b* are slide over the inner edge of the aperture **360** onto the face plate to provide a new aperture appropriately sized.

The LEDs of this exemplary embodiment can be of any kind, color (e.g., emitting any color or white light or mixture of colors and white light as the intended lighting arrangement requires) and luminance capacity or intensity, preferably in the visible spectrum. Color selection can be made as the intended lighting arrangement requires. In accordance with

the present disclosure, LEDs can comprise any semiconductor configuration and material or combination (alloy) that produce the intended array of color or colors. The LEDs can have a refractive optic built-in with the LED or placed over the LED, or no refractive optic; and can alternatively, or also, have a surrounding reflector, e.g., that re-directs low-angle and mid-angle LED light outwardly. In one suitable embodiment, the LEDs are white LEDs each comprising a gallium nitride (GaN)-based light emitting semiconductor device coupled to a coating containing one or more phosphors. The GaN-based semiconductor device can emit light in the blue and/or ultraviolet range, and excites the phosphor coating to produce longer wavelength light. The combined light output can approximate a white light output. For example, a GaN-based semiconductor device generating blue light can be combined with a yellow phosphor to produce white light. Alternatively, a GaN-based semiconductor device generating ultraviolet light can be combined with red, green, and blue phosphors in a ratio and arrangement that produces white light (or another desired color). In yet another suitable embodiment, colored LEDs are used, such are phosphide-based semiconductor devices emitting red or green light, in which case the LED assembly produces light of the corresponding color. In still yet another suitable embodiment, the LED light board may include red, green, and blue LEDs distributed on the printed circuit board in a selected pattern to produce light of a selected color using a red-green-blue (RGB) color composition arrangement. In this latter exemplary embodiment, the LED light board can be configured to emit a selectable color by selective operation of the red, green, and blue LEDs at selected optical intensities. Clusters of different kinds and colors of LED is also contemplated to obtain the benefits of blending their output.

While certain embodiments have been described herein, it will be understood by one skilled in the art that the methods, systems, and apparatus of the present disclosure may be embodied in other specific forms without departing from the spirit thereof. For example, while aspects and embodiments herein have been described in the context of certain applications, the present disclosure is not limited to such.

Accordingly, the embodiments described herein, and as claimed in the attached claims, are to be considered in all respects as illustrative of the present disclosure and not restrictive.

What is claimed is:

**1**. A luminaire comprising:
- a plurality of LEDs arranged in a matrix at a pitch P;
- the luminaire configured to drive each LED to produce L lumens; and
- a ratio of L to P being between approximately 59.2 lumens/inch and approximately 70.4 lumens/inch;
- wherein the luminaire does not comprise any one optic associated with more than one LED and the LEDs provide a combined even glow when illuminated.

**2**. The luminaire of claim **1**, wherein the LEDs are configured to be driven at approximately 650 mA.

**3**. The luminaire of claim **1**, P is approximately 0.625 inches.

**4**. The luminaire of claim **1**, the ratio of L to P is approximately 70.4 lumens/inch.

**5**. The luminaire of claim **2**, one of more of the plurality of LEDs being a 0.25 Watt LED.

**6**. The luminaire of claim **1**, wherein P is approximately 0.625 inches, the LEDs are configured to be driven at approximately 650 mA and the ratio of L to P is approximately 70.4 lumens/inch.

**7**. A luminaire comprising:
- a plurality of LEDs arranged in a matrix at a pitch P;
- the luminaire configured to drive each LED to produce L lumens; and
- a ratio of L to P being between approximately 59.2 lumens/inch and approximately 70.4 lumens/inch;
- wherein the luminaire does not comprise any one optic associated with more than one LED.

**8**. The luminaire of claim **7**, wherein the LEDs are configured to be driven at approximately 650 mA.

**9**. The luminaire of claim **7**, P is approximately 0.625 inches.

**10**. The luminaire of claim **7**, the ratio of L to P is approximately 70.4 lumens/inch.

**11**. The luminaire of claim **10**, one of more of the plurality of LEDs being a 0.25 Watt LED.

**12**. The luminaire of claim **7**, wherein P is approximately 0.625 inches, the LEDs are configured to be driven at approximately 650 mA and the ratio of L to P is approximately 70.4 lumens/inch.

**13**. A luminaire comprising:
- a plurality of LEDs arranged in a matrix at a pitch P;
- the luminaire configured to drive each LED to produce L lumens; and
- a ratio of L to P being between approximately 59.2 lumens/inch and approximately 70.4 lumens/inch, wherein each LED produces no more than 44 lumens;
- wherein the luminaire does not comprise any one optic associated with more than one LED.

**14**. The luminaire of claim **13**, wherein the LEDs are configured to be driven at approximately 650 mA.

**15**. The luminaire of claim **13**, P is approximately 0.625 inches.

**16**. The luminaire of claim **13**, the ratio of L to P is approximately 70.4 lumens/inch.

**17**. The luminaire of claim **16**, one of more of the plurality of LEDs being a 0.25 Watt LED.

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